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## Standing Committees appointed by direction of Council.

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Vol.
1900

*A paper presented at the 146th Meeting of the American Institute of Electrical Engineers, New York, September 26, 1900. President Hering in the Chair.*

# THE IMPERIAL PHYSICO-TECHNICAL INSTITUTION IN CHARLOTTENBURG.

BY HENRY S. CARHART.

## I. Historical.

Through the courtesy of Professor Kohlrausch, President of the Reichsanstalt, and the Curatorium or governing body of the institution, the writer was accorded the privilege of working in the Physikalisch-Technische Reichsanstalt as a scientific guest during the last few months of 1899. An unusual opportunity was thus afforded of learning rather intimately the methods employed and the results accomplished in this famous institution for the conduct of physical research, the supply of standards, and the verification of instruments of precision for scientific and technical purposes.

It is well-known that the Reichsanstalt is situated in Charlottenburg, a suburb of Berlin just beyond the renowned Thiergarten. The buildings occupy an entire square, the larger part of which, valued at 500,000 marks, was the gift of Dr. Werner Siemens. In making this gift, which was offered in land or money at the option of the government, Dr. Siemens declared that he had in mind only the object of serving his fatherland and of demonstrating his love for science, to which he avowed himself entirely indebted for his rise in life. The gift was made as a stimulus to the government to establish an institution for physical research. The kind of institution desired had been amply described in suitable memorials prepared by himself, Professor von

Helmholtz and others of scarcely less distinction. The first memorial bears date of June 16, 1883. It relates to "The Founding of an Institution for the Experimental Promotion of Exact Natural Philosophy, and the Technical Arts of Precision." It points out the need of such an institution, details the benefits likely to accrue from it, lays great stress on the intimate relation existing between scientific investigations and their application in the useful arts, and sets forth somewhat in detail a plan of organization. The memorialists had in mind at that time a "Physico-Mechanical Institution," but in a memorial of the following year (March 20, 1884) the title was changed to the one which the institution now bears—"Physikalisch-Technische Reichsanstalt." From this second memorial it is learned that the first steps toward the furtherance of exact science and technical precision in an institution to be founded and maintained by the State, were taken as early as 1872. This movement had the support of the crown prince, the late Emperor Frederick, and the matter was taken in hand by Count von Moltke as chairman of the Central Bureau for Metrology in Prussia. He called together a commission near the end of the year 1873, and in the following January this commission reported a series of propositions for the improvement of the scientific mechanic arts, and of instruments of precision. These propositions formed the foundation for a memorial on the same subject to the Chamber of Delegates of the Prussian Government in 1876. The result was that appropriate rooms were set aside in the new building of the Technical High School in Charlottenburg for the organization of an institution for the cultivation of the arts of precision.

The general plan of the Reichsanstalt was adopted in 1887, and an appropriation of 868,254 marks was made and spread over the budget for three years. The main building for the first or scientific division was completed in 1893. The second or technical division was housed in a portion of the Technical High School till the buildings for this division were completed in 1897. All departments of activity of the Reichsanstalt are now accommodated on the square facing on March Strasse in Charlottenburg. They include the division for pure scientific research, mechanical measurements of precision, electrical measurements and instruments, the measurement of large direct and alternating currents and electromotive forces, the optical department, the department of thermometry, the department of pyrometry, and the department of chemistry. To these as auxiliaries should be added the power plant and the workshop.

## II. ORGANIZATION.

The two divisions into which the Reichsanstalt is divided correspond to the two paramount objects which the founders had in view, viz., research in pure science, and the cultivation of precision in the technical applications of science. The same idea is embodied in the very name of the institution—The Imperial Physico-Technical Institution. If the sole purpose of the Anstalt had been the promotion of improvements in the mechanic arts, in engineering, and in instruments of precision, the first or scientific division would still have been essential to secure the ends sought. All the applications of science rest on the foundation of pure scientific discovery. The creation of new and improved methods and instruments for physical measurements requires the most exhaustive and painstaking investigations as a preliminary to a steady and confident advance. The practical value of research in pure science is no longer in question. The wise founders of the Reichsanstalt made no mistake in coupling an institution for the promotion of technical precision with one for the prosecution of research in physical science.

The governing body or Curatorium of the Reichsanstalt is appointed by the Emperor. At its head is Herr Weymann, Imperial Privy Counsellor. The function of the Curatorium is the appointment of the officials and the general management of the institution. The chief officer of the Reichsanstalt is the President, and the most distinguished physicist of the realm is sought for this position. Helmholtz was taken from the University in Berlin to become the first incumbent of the office; after his death in 1894, his successor as professor of physics in the University, Professor F. Kohlrausch, became his successor as President of the Reichsanstalt.

The President, who is at the same time director of the first division, is held responsible for the successful work of the Reichsanstalt. All other officials are therefore subordinate to him. In his absence the duties of his office devolve upon the Director of the technical division. Subordinate to the Director of this second division are the professors, associates, and assistants of various grades. A professor in charge of a department has the direction of all those employed in it, including a skilled departmental mechanician.

The specific duties of the President may be briefly enumerated. He must lay before the Curatorium at its annual meeting the following:

1. A report on the work executed in both divisions.
2. The plan of work for the undertakings to be carried out the ensuing year.
3. Propositions relative to the money to be expended for scientific and technical work; also for salaries and remunerations.
4. Propositions relative to the rank of permanent associates and assistants; also relative to the bestowal of places to work in the Reichsanstalt as scientific guests.

Fig. 1.—President's House.

He takes a vote on the propositions in 3 and 4, and reports the conclusions of the Curatorium to the government for approval. It is also the duty of the President to sign vouchers for all payments, and he is held responsible for the proper expenditure of the money appropriated for the maintenance of the institution.

The different functions of the two divisions composing the institution are defined in rather broad terms. It is the duty of the first division to carry out physical investigations requiring more uninterrupted time on the part of the observer, and better accessories in the way of instruments and local appliances, than private individuals and laboratories of institutions for teaching as a rule can offer. These investigations shall be carried out partly by officers of the Anstalt and partly, under their oversight, by scientific guests and voluntary workers. By scientific guests in general are meant the holders of scientific positions in the German empire, who wish to prosecute scientific researches, the plan of which they have submitted, and for which they have not at home the necessary appliances. They must be recommended by the State in which they reside and must be accepted by the Curatorium.

FIG. 2.—Building for Large Current and Machinery.

Young men may be accepted as voluntary workers who have proved their ability by scientific publications. They will undertake researches which have been determined upon by the Curatorium or the Director; or they may investigate subjects which they themselves suggest, and which appear to the Director to be practicable and worthy of execution. The scientific results obtained must be published only at the discretion of the authorities of the institution, who reserve also the right to publish them in the researches of the Reichsanstalt. Provision is made that voluntary workers shall not use the institution for private ends nor to obtain patents.

The second division of the Reichsanstalt is placed under a Director, who is subject to the higher authority of the President. Such a Director was considered necessary on account of the special work of this division, as well as because of the intimate relations into which it is brought with many persons engaged in industrial pursuits. He should therefore not only be a scientific man but should at the same time have some technical knowledge of the applications of science. Under the Director are placed the permanent heads of the subdivisions of the technical department, one having the oversight of thermometry, one of optics, two of electricity, and one of mechanical measurements of precision. Along with these and of the same rank and compensation is the director of the workshop. Under him at present are eight mechanics, and the shop is provided with the finest tools for the execution of the most exact work required by the institution. For

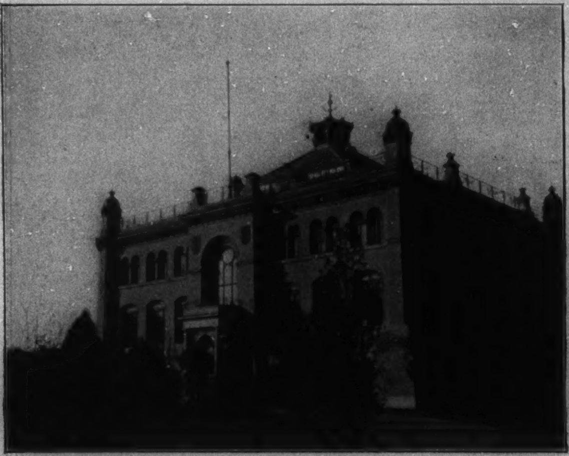

FIG. 3.—Main Building, Division I.

example, it has a circular dividing engine that cost $2,500. The founders of the Reichsanstalt foresaw the necessity of such mechanical aids for the furtherance of the exact work to be undertaken. They wisely concluded that such special constructions and new types of instruments as they might require from time to time could be more conveniently and more cheaply built in their own shop than by private instrument makers.

## III. Cost and Maintenance.

The following are the official accounts of expenditures for the grounds, buildings, furniture and instruments for the two divisions, to which are added the yearly expenses:

Fig. 4.—Main Building, Division II.

### Division I.

| | | |
|---|---|---|
| 1. | Acquisition of ground, the gift of Dr. Werner Siemens | 500,000 M. |
| 2. | For erection of buildings: | |
| | a. Main Building | 387,000 " |
| | b. Machinery Building | 50,000 " |
| | c. Administration Building | 100,000 " |
| | d. President's House | 99,254 " |
| | e. Grading, Paving, etc | 10,473 " |

| | | | |
|---|---|---|---|
| f. | Paving Half of Street | 30,274 " | |
| g. | Building for Battery | 8,500 " | |
| 3. | Fittings and Furniture | 58,000 " | |
| 4. | Equipment of Machinery and Instruments | 82,310 " | 1,325,810 M. |

## DIVISION II.

| | | | |
|---|---|---|---|
| 1. | Acquisition of Ground | 373,106 M. | |
| 2. | Erection of Buildings: | | |
| a. | Main Building | 922,000 " | |
| b. | Laboratory Building | 218,000 " | |
| c. | Machinery " | 180,000 " | |

FIG. 5.—Main Building. (In part.)

| | | | |
|---|---|---|---|
| e. | Dwelling for Officials | 140,000 " | |
| f. | Additional Improvements | 348,000 " | |
| 3. | Fittings and Furniture | 108,300 " | |
| 4. | Equipment of Machinery and Instruments | 471,390 " | |
| | | 2,760,796 " | |
| | Less reduction for 1895–96 | 47,500 " | 2,713,296 M. |
| | Divisions I and II together | | 4,039,106 " |

The annual expenditures for 1889 were as follows:

| | | |
|---|---|---|
| 1. | **Expenditures for Salaries and Laborers** | **206,604 M.** |
| 2. | **Miscellaneous Articles, Experimental Work and care of Buildings** | **127,000 "** |
| | **Total** | **333,604 ".** |

The receipts for calibrating instruments, testing materials, verifying standards and the like now amount to about 40,000 M. annually. This sum should be deducted from the yearly expenditures, leaving a net sum of about 300,000 M.

In round numbers the Reichsanstalt has cost $1,000,000, and the annual appropriation for its maintenance is $75,000.

## IV. Results.

A very pertinent inquiry is, what are the results of all this expenditure? Might not more good be accomplished by state aid to some existing technical school or university? The results attained must be set by the side of the objects which the founders of the institution had in view in order to ascertain whether the sequel has justified their predictions. In the memorials to which reference has already been made, Professor von Helmholtz and Dr. Werner Siemens pointed out the advantages likely to accrue to Germany from the maintenance of an imperial institution for research, which should at the same time assume the cognate function of fixing and certifying standards of mechanical and physical measurements. Attention was drawn to the fact that other countries, notably England, had enjoyed great renown in science because of the brilliant researches and discoveries of some of her scientific men, who had the good fortune to be possessed of leisure and large private means, and the scientific spirit to devote them to investigations demanding both as a *sine qua non.*

These conditions the memorialists declared were lacking in the fatherland. Her scholars who had the enthusiasm and the capacity for exact scientific investigation possessed neither the private fortune to devote to it, nor the uninterrupted time for the execution of the work. They were to be found among the men engaged in teaching, but their professional duties absorbed their time to such an extent that only an inadequate residue remained; and even that little was divided into fractions too small to admit of the sustained and continuous attention which any important investigation demands.

It was further pointed out that if the government would supply the conditions favorable to scientific discovery, the men could be found whose work would reflect great credit on the state, while the interaction between pure science and its applications to arts and manufactures would put Germany in the forefront of scientific renown and of the intelligent application of science to useful purposes.

It was further urged by von Helmholtz that the brilliant investigations of Regnault and other French physicists many years ago should now be repeated with the superior methods and instrumental appliances available at the present time. These investigations drew the attention of the scientific world to France and made it the focus of scientific interest. Her instrument makers, even up to the present, have reaped a rich reward in foreign orders for instruments made eminently desirable and almost indispensable by these distinguished French investigators.

Other problems, too, needed solution, problems forced to the front by modern requirements and discoveries. The applications of electricity, for example, present new questions for science to answer, while the interests of the consumer at the same time call for some form of control by the State of the instruments employed in fulfilling contracts. The very units in which such measurements are made need to be authoratively settled—a task demanding the highest manipulative skill in experiment and the most refined appliances which experience can suggest and money purchase.

The German government admitted the force of these considerations and made splendid provision, both for pure science and its technical applications, by founding the Imperial Institution at Charlottenburg. The results have already justified in a remarkable manner all the expenditure of labor and money. The renown in exact scientific measurements formerly possessed by France and England has now been largely transferred to Germany. Formerly scientific workers in the United States looked to England for exact standards, especially in the department of electricity. Now they go to Germany. So completely has the work of the Reichsanstalt justified the expectations of its founders, and so substantial are the products of this already famous institution that other European nations are following Germany's example. Great Britain has already made an initial appropriation for a National Physical Laboratory to be organized on a plan similar to that of her Teutonic neighbor. Mr. R. T. Glazebrook, who has long served as Secretary of the Electrical Standards Com-

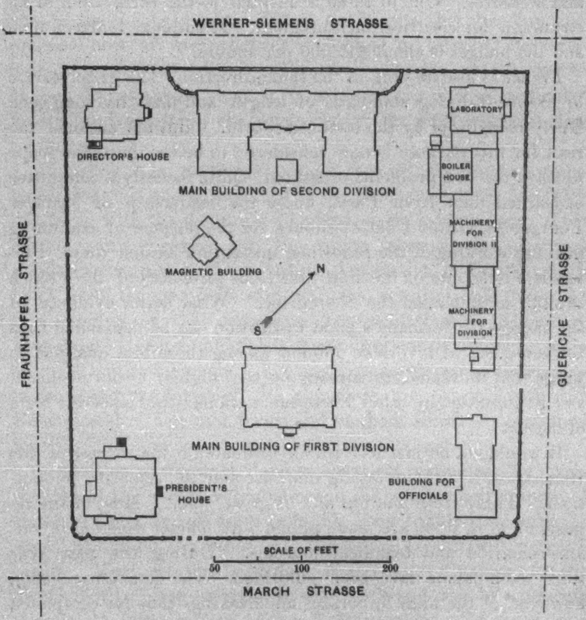
WERNER-SIEMENS STRASSE
DIRECTOR'S HOUSE
MAIN BUILDING OF SECOND DIVISION
LABORATORY
BOILER HOUSE
MACHINERY FOR DIVISION II
MACHINERY FOR DIVISION I
MAGNETIC BUILDING
N
S
FRAUNHOFER STRASSE
GUERICKE STRASSE
MAIN BUILDING OF FIRST DIVISION
PRESIDENT'S HOUSE
BUILDING FOR OFFICIALS
SCALE OF FEET
50
100
200
MARCH STRASSE

FIG. 6.—General Plan of Ground and Buildings.

mittee of the British Association for the Advancement of Science, has been appointed Director and has entered on his duties. The new institution will absorb the old Kew Observatory, and other buildings will be added at once for the extension of the functions of this Observatory so as to include the larger enterprise contemplated in the establishment of the new National Laboratory.

Russia also has a number of large and well equipped laboratories in connection with her Central Bureau of Weights and Measures. One of these is devoted to the verification of instruments for electrical measurement. It employs fourteen men and the budget is about $45,000 per annum.

France is also moving in the same direction. The great service of France in fixing standards of length and mass has long been freely recognized by the civilized world. But her national bureau for this purpose is now considered to be too limited in scope to solve the new problems presented. Quite recently a committee of learned men from Paris, under the leadership of Minister Bourgeoise, visited Charlottenburg for the purpose of examining into the working of the renowned institution located there. Professor Violle, one of the most illustrious physicists of the French capital, accompanied the committee. What better evidence of the success of Germany's great institution can be demanded than the consensus of favorable opinion among those best qualified to judge that its fruits are already of the highest order of merit, and its imitation by other European nations—the sincerest form of flattery.

It would not be just to form an estimate of the success of the Reichsanstalt without taking into account its scientific publications. These are numerous and of great value. Most of the reports of work done are made public with official sanction in various scientific and technical journals. During the past year thirty such papers have been published. The detailed accounts, however, of the most important undertakings thus far completed are contained in three quarto volumes of investigations. Among those contained in the first two volumes may be mentioned papers pertaining to thermometry and to units of electrical resistance.

The investigations in thermometry comprise such topics as the influence of the glass on the indications of the mercurial thermometer, division of the thermometer and determination of the errors of division, determination of the coefficient of outer and inner pressure, determination of the mean apparent coefficient of expansion of mercury between 0°C. and 100°C. in Jena glass, and investigations relating to the comparison of mercurial thermometers.

Four papers of exceptional value relate to normal standards of electrical resistance. They are, the probable value of the ohm according to measurements made up to the present time, the determination of the caliber correction for electrical resistance tubes, the normal mercury standard ohm, and the normal wire standard ohm of the Reichsanstalt. When one recalls that the ohm as a practical unit of measurement is defined in terms of the resistance of a specified column or thread of mercury, it will readily be seen that the work done at Charlottenburg in this particular field is fundamental in character and of the most universal importance.

In passing it is worthy of remark that all the standard resistances designed and constructed at the Reichsanstalt are carefully compared with the mercurial standards early in each year. This custom is in accordance with the action taken by the electrical standards committee of the British Association at Edinburgh in 1892, when the mercurial standard was definitely adopted. At this meeting of the committee, representatives of American, French and German physicists (including von Helmholtz) were invited to sit as members. The methods employed in these comparisons and the forms of the standards are original with the Reichsanstalt. The new forms and methods admit of a combined accuracy and convenience not previously attained.

In addition to the work done in electrical resistance, the investigation of the silver voltameter and the electromotive force of standard Clark and Weston cells has been highly productive of useful results for the other two fundamental electrical measurements. Much remains to be done in this latter direction, for the electromotive force assigned to the Clark and the Weston cell, even in the latest report of the Reichsanstalt, is derived from measurements by the silver voltameter, while the electrochemical equivalent of silver is in doubt to a greater extent than the electromotive force of the Clark cell.

Perhaps the best indication of the valuable work of the Reichsanstalt is to be found in the annual "Thätigkeitsbericht." This report of the year's activity is published in the "Zeitschrift für Instrumentenkunde," and the reprint for 1899 forms a pamphlet

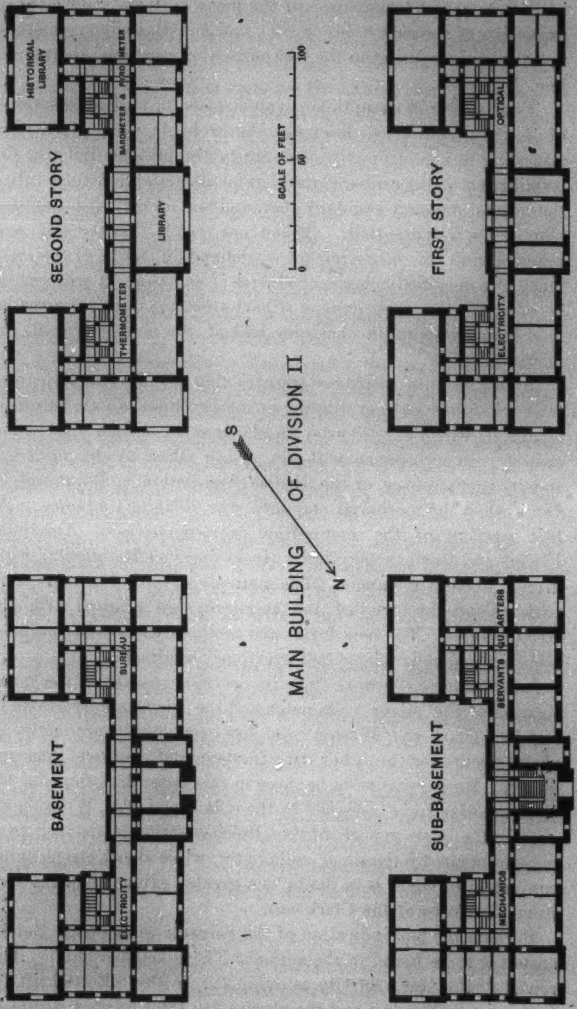
SECOND STORY
HISTORICAL LIBRARY
BAROMETER & PYROMETER
LIBRARY
THERMOMETER
SCALE OF FEET
0
50
100
FIRST STORY
OPTICAL
ELECTRICITY
MAIN BUILDING OF DIVISION II
S
N
BASEMENT
BUREAU
ELECTRICITY
SUB-BASEMENT
SERVANTS QUARTERS
MECHANICS

FIG. 7.—Floor Plans of Main Building. Division II.

of twenty-five large, closely printed pages. The following abstract will convey some impression, though an imperfect one, of the extent of the work accomplished:

### First (Physical) Division.

I. *Work in Heat.* Determination of the density of water between 0°C. and 40° C.

Determination of the pressure of water vapor at low temperatures.

Determination of the pressure of water vapor near 50° C.

Investigation of thermometers for temperatures between 100° and 200° C.

Investigation of the nitrogen thermometer with a platinum-iridium bulb for very high temperatures.

Investigation of thermometers for low temperatures.

Determination of the thermal and electrical conductivity of pure metals. (These determinations are to be extended down to the temperature of liquid air and up to 1000° C.)

Investigations with the Fizeau-Abbe dilatometer.

Investigation of the transmission of heat through metal plates.

II. *Work in Electricity.* Comparison of the normal wire resistances of Divisions I and II.

Determination of the capacity of an air condenser.

Comparison of the standard cells of Divisions I and II.

Determination of the conductance of water solutions with a higher degree of accuracy than has been attained hitherto, especially with very dilute solutions.

III. *Work in Light.* Investigation with electrically heated black bodies.

Proof of Stefan's law between 90° and 1700° absolute temperature.

Determination of the relation between the intensity of light and the temperature.

Measurement of radiation in absolute measure.

Determination of the distribution of energy in the spectrum of black bodies.

Determination of the distribution of energy in the spectrum of polished platinum and other substances; also their reflective power.

### Second (Technical) Division.

I. *Work of Mechanical Precision.* Investigation of the errors of length and of the division of 300 scales, tubes, etc.

Coefficient of expansion of 18 bars, tubes and wires.

Verification of 86 tuning forks for international pitch.

Construction of a new transverse comparator.

Study of the variations of angular velocity of rotating bodies.

II. *Electrical Work.* Calibration of direct current apparatus, 183 pieces.

Calibration of alternating current apparatus, 58 pieces.

Examination of other electrical apparatus, 76 articles.

Examination of accumulators, primary elements and switches, 37 articles.

Examination of insulating and conducting materials and carbons, 28 articles.

Installation of storage cells for a current of 10,000 amperes.

Installation of small storage cells for an electric pressure of 20,000 volts.

Installation of alternating current instruments for measuring potential difference up to 500 volts and current up to 100 amperes.

Examination of 29 samples of alloys for specific resistance and temperature coefficient.

Examination of 126 samples of insulating materials with an electric pressure up to 800 volts.

Verification of single resistances, 123 samples.

Calibration of 83 resistance boxes, compensation apparatus, etc., containing 1153 single resistances.

Comparison and verification of 133 standard cells—111 Clark and 22 Weston elements.

Determination of the ratio Clark 15° C. to cadmium 20° C., and Clark 0° C. to cadmium 20° C. with a large number of standard cells.

Examination of 21 samples of dry and storage cells.

Calibration of 15 galvanometers to measure high and low temperatures with thermal elements.

Magnetic examination of 25 samples of iron and steel.

Investigation of the difference between the continuous and the discontinuous magnetization of steel.

Investigation of the influence of repeated heating on the magnetic hardness of iron.

III. *Work Relating to Heat and Measurement of Pressure.* Calibration of 18,777 thermometers.

Examination of 4 safety appliances and benzine lamps.

Calibration of 317 thermal elements.

Verification of 9 manometers and 22 barometers.

Testing of 190 samples of apparatus for petroleum investigations.

Testing of 3210 samples of safety rings and plugs.

Testing of 22 samples of indicator springs.

IV. *Work in Light.* Testing of 149 Hefner lamps for photometric purposes.

Testing of 189 incandescent lamps.

Testing of 143 gas and other lamps and adjunct appliances.

Investigation of the relation between the temperature of sugar solutions and their rotatory power on polarized light.

Investigation of quartz plates for the examination of sugars.

Determination of 100 points in the normal Ventzke scale for sodium light.

Especially careful collection of sugars from Germany, Austria, France, Russia and North America for the investigation of specific rotatory power.

V. *Work in Chemistry.* Continuation of the study of the solubility of important salts.

Electrolysis of platinic chloride and the migration of the ions.

The quantitative determination of metallic platinum.

Investigation of liquids for use in thermometers to measure low temperatures.

In addition to the above work attention is drawn to the fact that there are two institutions for calibration and certification of thermometers under the control of the Reichsanstalt, one at Ilmenau and the other at Gehlberg. During the last ten years the institution at Ilmenau has tested in round numbers 350,000 thermometers.

The number of persons employed in the Reichsanstalt the past year was 87.

## V. A LESSON FOR US.

If Germany has found it to her scientific and industrial advantage to maintain the Reichsanstalt, and is proud of what it accomplishes; and if Great Britain is so impressed with the success of the institution that she has decided to imitate it, it is surely the part of wisdom for the United States to move in the same direction. It is therefore very gratifying that at the suggestion of Secretary Gage a bill was introduced in the last Congress to establish a National Standardizing Bureau, and that the Committee on Coinage, Weights and Measures reported unanimously and strongly in favor of its passage. So great is the importance of this movement from the point of view of science, of national pride, and of the higher interests of industrial pursuits, that the effort so happily begun, to secure suitable legislation should be repeated with redoubled force and enthusiasm. Some of the reasons for making this effort one does not need to go far to seek.

In the first place the scientific interests to be served are certainly as great as in any other country in the world. Science is cultivated here with increasing assiduity and success. We are no longer content to follow in the footsteps of European savants and modestly repeat their investigations. Original work of a high order is now done in many American universities; but the difficulties under which university instructors prosecute research are even greater here than in Germany, and we are still compelled to go to Europe for most of our standards. As a result, inventions of an almost purely scientific character originating here have been carried to perfection in the Reichsanstalt, and Germany gets the larger part of the credit. I need only instance the Weston standard cell, which has been so fully investigated at the Reichsanstalt, and the alloy "manganin," which the same institution employs for its standard resistances after a searching inquiry into its properties. Both of these are the invention of Mr. Edward Weston, one of the Past-Presidents of this INSTITUTE. So long as there is no authoritative bureau in the United States under Federal control, and presided over by men commanding respect and confidence, we must continue "to utilize the far superior standardizing facilities of other governments." It is true that science knows no nationality, but the scientific workers of any nation can serve their own country better if they are not compelled to obtain their standards and their best instruments from distant parts of the globe. America has the cultivation in physical science, the ability on the part of her investigators, and the inventive faculty to do work in a national institution that we shall not be ashamed to place by the side of Germany's best products. The establishment of a national institution for physical and technical purposes can not fail to foster a vigorous and healthy growth in science, to which we already owe so much of our national prosperity and renown.

In the second place Congress should be stimulated to take action because of national pride. It is not creditable for a capable and self-reliant nation to continue to depend on foreign countries for its standards of measurement, for the certification of its instruments, and for the calibration of its normal apparatus for precise work. Different departments of our Government and offices under its control must at present appeal to foreign bureaus for the certification of their standards and instruments of precision. The first day the writer spent at the Reichsanstalt he was consulted with reference to an extended correspondence between the Director of the technical division and the officials of the Brooklyn Navy Yard relative to the calibration of a large number of incandescent electric lamps for use in our Navy department. The spectacle of a Government bureau going to a foreign imperial institution for standards in an industry whose home is in the United States is a humiliating one. Yet the proceeding was entirely proper and justifiable because there is in this country no standardizing bureau for the purpose desired. Are the representatives of the American people willing to have this state of affairs continue?

Again, the higher interests of the industrial utilization of scientific knowledge require the establishment in Washington of an institution similar to the Reichsanstalt and in no degree inferior to it. We are an inventive people and may justly claim renown in the prompt and efficient utilization of the discoveries in physical science. It is highly improbable that a practical limit has already been reached in the field of applied physics. We are not estopped from making further discoveries. Still it may be affirmed with confidence that the most important and promising work to be done, except in the rare instances in which genius makes a brilliant discovery, will consist in the more perfect adaptation of known physical laws to the production of useful results. It is precisely this field which has not been extensively cultivated as yet in the United States. We have explored the surface and presumably gathered the largest nuggets and the most brilliant gems. To increase the output we must now delve deeper and scrutinize more closely. To drop the metaphor, what will be required for future preeminence is the more intensive and exhaustive study of the scientific conditions in the industrial utilization of physical laws. This study will require the best talent of our technical schools, aided and supported by an authoritative national institution, itself far removed from patents and commercial gains, but jealous of our national renown and eager to coöperate with manufacturers for the sake of national prosperity.

Germany is rapidly moving toward industrial supremacy in Europe. One of the most potent factors in this notable advance is the perfected alliance between science and commerce existing in Germany. Science has come to be regarded there as a commercial factor. If England is losing her supremacy in manufactures and in commerce, as many claim, it is because of English conservatism and the failure to utilize to the fullest extent the lessons taught by science; while Germany, once the country of dreamers and theorists, has now become eminently practical. Science there no longer seeks court and cloister, but is in open alliance with commerce and industry. This is substantially the view taken by Sir Charles Oppenheimer, British Consul-General at Frankfurt, in a recent review of the status and prospects of the German Empire.

The Reichsanstalt is the top stone of Germany's scientific edifice. It has also contributed much to her industrial renown. It is necessary to cite only her manufactures involving high temperatures, such as the porcelain industry, to appreciate the help afforded by the Reichsanstalt. The methods and instruments elaborated there for the exact measurement of high temperatures constitute a splendid contribution toward industrial supremacy in those lines. The German government sees with great clearness that the Reichsanstalt justifies the expenditure made for its maintenance, not by the fees received for certifications and calibrations, but by the support it gives to the higher industries requiring the application of the greatest intelligence. In this connection it should be thankfully acknowledged that the services of this imperial establishment are placed at the disposal of foreign institutions of learning with the most generous liberality. The charges for calibration are only about one-fourth the expense incurred in making them, but the support thus given to German makers of instruments of precision, by increasing their foreign orders, is deemed a sufficient return for the services rendered.

# AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

NEW YORK, April 25th, 1900.

The 142d meeting was held at 12 West 31st Street, this date, and was called to order at 8:35 P. M. by Manager Steinmetz.

THE CHAIRMAN:—The meeting is called to order. I give the floor to the Secretary to make some announcements.

SECRETARY POPE:—At the meeting of the Executive Committee this afternoon the following associate members were elected:

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| BARR, JOHN B. | Electrical Engineer General Electric Co., residence 234 Union Street, Schenectady, N. Y. | C P. Steinmetz.<br>Ernest Berg.<br>A. H. Armstrong. |
| BROWNE, WM. HAND, JR. | Asst. Professor of Electrical Engineering, The University of Illinois, Urbana, Ill. | R. B. Owens.<br>Wm. Esty.<br>Wm. S. Aldrich. |
| COLE, WM. HOWARD | Engineer, Ferrocarriles del Districto Federal, Mexico City, Mexico. | C. F. Beames.<br>A. E. Worswick.<br>P. H. Evans. |
| GUERRERO, JULIO | Associated with the Durango Electric Light Co., Victoria, 12 Durango, Mex. | C. F. Beames.<br>P. H. Evans.<br>M. T. Thompson. |
| GUTIERREZ, MANUEL R. | Professor of Physics, Normal School, Jalapa, Mexico. | M. T. Thompson.<br>P. H. Evans.<br>C. F. Beames. |
| HANSCOM, WM. W. | Chief Electrical Engineer, Union Iron Works, 612 O'Farrell Street, San Francisco, Cala. | F. F. Barbour.<br>H. A. Russell.<br>J. A. Lighthipe. |
| LEAMY, J. M. | Electrician, Dominion Government, 250 Lyon St., Ottawa, Canada. | T. Ahearn.<br>A. A. Dion.<br>Ralph W. Pope. |
| LIVSEY, J. H. | Salesman and Manager Detroit Office General Electric Company, 704 Chamber of Commerce, Detroit, Mich. | W. L. R. Emmet.<br>Alex Dow.<br>A. F. Walker. |
| MARSHALL, CLOYD | Designer of Electrical Machinery, Jenney Elec. M'f'g, Co., Indianapolis, Ind. | Harold B. Smith.<br>W.E.Goldsbor'gh.<br>C. P. Matthews. |

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| **McClure, William J.** | Associated with H. D. Brown, Electrical Engineers and Contractors, residence, 259 West 52nd Street, New York City. | W. H. Ripley.<br>F. B. Crocker.<br>M. I. Pupin. |
| **Moore, John Peabody** | Tester, General Electric Co., P. O. Box 389, Schenectady, N. Y. | A. F. McKissick.<br>R. W. Pope.<br>W. E. Boileau. |
| **Oolgaardt, J. J.** | Electrical Engineer, (Foreign Dept.) General Electric Co., residence, Edison Hotel, Schenectady, N. Y. | Ernst Berg.<br>C. P. Steinmetz.<br>A. L. Rohrer. |
| **Osborne, Marshall** | Engineer in charge of Contracts, The British Thomson-Houston Co., 83 Cannon St., London, Eng. | H. F. Parshall.<br>H. M. Hobart.<br>Ralph W. Pope. |
| **Slichter, Walter I.** | Electrical Engineer, General Electric Co., residence, 234 Union St., Schenectady, N.Y. | C. P. Steinmetz.<br>Ernst Berg.<br>A. H. Armstrong. |
| **Somellera, Gabriel F.** | Partner, Salcedo & Co., Apartado 115, Mexico City, Mexico. | C. F. Beames.<br>J. H. Shearer.<br>P. H. Evans. |
| **Steele, Walter D.** | Electrical Engineer Public Light Commission, The City of Detroit, 40 Atwater St., E. Detroit, Mich. | Alex Dow.<br>E. P. Warner.<br>Jesse M. Smith. |
| **Varley, Richard Jr.,** | President, the Varley Duplex Magnet Co., 138 7th Street, Jersey City, residence, Englewood, N. J. | Townsend Wolcott<br>E. A. Colby.<br>H. Laws Webb. |
| **de Waal Wm. H.** | Engineer, Accumulator M'f'g Co., Cadena, No. 3, Mexico City, Mexico. | C. F. Beames.<br>P. H. Evans.<br>M. T. Thompson. |

The following associate members were transferred to full membership:

Approved by Board of Examiners, March 9th, 1900.

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| **William S. Aldrich** | Professor of Electrical Engineering, University of Illinois, Urbana, Ill. |
| **Harold B. Smith** | Professor of Electrical Engineering, Worcester Polytechnic Institute, Worcester, Mass. |

The Chairman:—It is very encouraging to see the growth of the Institute and note the spreading of its membership, not only through the United States, but even in the foreign countries of both hemispheres.

The next topic in order is the reading of a paper on "Hysteresis in Sheet Iron and Steel," by Arthur Hillyer Ford, to whom I give the floor.

[See p. 135, March issue.]

## DISCUSSION.

**MR. FORD**:—I might say a few words about the origin of these samples. At first I started out to make separate tests of samples cut with their length parallel to the length of the sheet, and samples cut crosswise of the sheet and found that there was some difference in the hysteresis, but owing to the tediousness of making the tests, part of these were thrown out, so that all the samples represented in this paper are samples of different kinds of iron. There may be in some cases iron of two or more thicknesses obtained from one manufacturer. The majority of the specimens were obtained from transformer manufacturers, though some were obtained directly from the iron makers. Some attempt was made to get the method of working the iron, but as you will see from the table this was not entirely successful.

**THE CHAIRMAN**:—We have listened to a very interesting paper, and discussion is now in order. Before beginning the discussion, however, I would like to ask the author a question for information and explanation. If I understand right, Table III gives the hysteresis constant of iron which has been annealed and then quenched in water. Starting from different temperatures, in the first part of Table III it gives the hysteresis constant after this heat treatment; the second part gives hysteresis constant after additional treatment, and the third part gives increase of hysteresis constant. I do not find, however, the original hysteresis constant before the heat treatment has already been taken.

**MR. FORD**:—In Table III., column E, you will find the results of a preliminary test made on the samples as received. The only treatment which these samples had received was a slight heating due to the action of the shears in cutting the samples and that due to filing the ends. The samples were placed in a hardened steel clamp and filed to an exact length, which, of course, heated them considerably.

**DR. SAMUEL SHELDON**:—In Part II. of this paper we have a description of how over a hundred samples of sheet iron or steel have been subjected to various heat treatments, and how the hysteresis losses and the hysteretic constants have been measured for each of these samples after the various treatments. As a result, there has been found either quite a noticeable increase in the value of the hysteretic constant due to the treatment, or very little change at all; in the latter case either a little decrease in the hysteretic constant or a slight increase. The different heat treatments seem to show no like effect on the different samples. It is pertinent to ask what the heat has done to increase the hysteretic constant in those cases where it has noticeably increased it. Transformer sheet irons, like all rolled metals, are allotropic as regards density. In the direction of the length of the sheet there is a less density than there is in a direction at right angles to that of rolling. Sheet iron, in order to have a small hysteretic constant, should be least dense in the direction of magnetization and most dense along the magnetic equipotential surfaces. Now in this case, as was mentioned by the author, after the conclusion of the paper, there was no regular rule followed as to the cutting out of the samples from the sheet. The samples, which were cut out to fit, as I understand it, Ewing's hysteresis measurer, are quite a good deal longer than they are wide, being three inches long and about half an inch wide. In those cases where the length of the sample was along the direction of the drawing out of the plates, or in the direction of the least density, heating would cause a rise in the hysteretic constant. This is because a lessening of the density in a direction at right angles to the magnetic flux has the same effect as an increase of density in the direction of the magnetic flux. Compacted bodies which have been passed through rolls, when afterward subjected to heat, increase in size in a direction at right angles to the direction of rolling and the increase is a permanent increase. This was called to my attention first, I think, in connection with some brass binding-posts, whose perfectly fitted screws were heated by a current passing through them. As a result they grew so large in diameter that they would but tightly fit their holes. They were turned down so as to fit loosely and they were again heated. Again they grew large enough to fill the holes. Under the application of heat, they grow and permanently keep a larger diameter. The mere heating of a sample of iron, which has just come from the rolls, would increase the hysteretic constant, if the magnetization were in the direction along which the strip had been pulled out from the rolls; it would increase it permanently. If, however, the magnetization were at right angles to the grain of the metal, the increase of size in the direction of the magnetization, due to heating, would decrease the hysteretic constant, and the accompanying increase of size in the direction which is at right angles with the previous direction and which is in the direction of the thickness of the plate would increase it to about the same extent. Now it seems to me that those samples, which upon test have shown no very marked increase or decrease, were cut out so that afterwards the magnetization was in a direction perpendicular to the grain; whereas those which have shown a marked increase in the hysteretic constant were cut so that the magnetization was in the direction of the grain.

Mr. Ford:—I would say in this connection that about the first fifteen samples, I believe, were those of which I had specimens cut both ways of the sheet, and, as I remember it, those which were tested finally were those in which the magnetization was parallel to the grain of the iron; but in the preliminary test, referred to in column E, no difference in the aging was noticed between those which were cut at right angles to the grain and those which were cut lengthwise of the grain.

A matter of interest in this connection is the effect of intense cold on the hysteresis constant. We usually consider that this is rather stable at or below atmospheric temperature; but such is not the case, as was shown by a simple experiment. Four specimens of sample No. 14 (steel) were taken, and by mixing the sheets of which they were composed their hysteresis constants were made equal.

Specimens cut side by side from the same sheet will have different constants, so that this shuffling was necessary in order to have the four samples the same. These samples having an initial hysteresis constant of .00124, were put in a beaker of liquid air having a temperature of, approximately, — 210° C., and allowed to stay there until thoroughly cool.

They were then taken out and put in the hysteresis tester and the constant determined while they were cold, and found to be .00159. After this they were warmed to the temperature of the room, about 20° C., and the constant found to be .00139, showing a permanent increase in the hysteresis constant of 12% and a temporary increase of 28%.

Mr. Steinmetz:—[The Secretary, in the Chair] This paper is very interesting in what it gives and what it does not give. It does not really give a solution of the problem, namely, why does iron age, and how can aging be avoided, nor does it give the reason why one sample of iron has a high hysteresis loss and the other a low hysteresis loss. It only shows again that the chemical constitution has nothing to do with the hysteresis, but that hysteresis loss depends largely on the physical constitution of the iron, and on the chemical constitution probably only indirectly in so far as the physical constitution depends on the chemical to a certain extent. That is, very pure iron probably is independent of the chemical constitution, but as 1% or 2% of carbon gets in, you will find entirely different values of hysteresis constant because you find entirely different physical constitution. You find this in brittle cast iron for instance. There is one feature which strikes me in all these tables: that is these very low value of the hysteresis constant, some going down below 1. Now these are values very much lower than I have found, and I am very suspicious that the absolute values are not correct. I should rather suspect, and believe we have reason to suspect, from my knowledge of the instrument with which these tests were made that there is a constant error in all the readings, which makes them less than they should be. This does not impair the value of the paper, but merely means that we cannot rely on these measurements. Referring to Table III. the lowest of which I have absolute record is 1.24, and that was a very exceptionable case, and here are quite a number which go far below that. But there is one very interesting feature regarding this aging in the table giving the percentage of aging. That is, we do not find that the different kinds of iron age differently, but we do find that some iron does and other iron does not age, because you see there are hardly any intermediary values. All these values are very low values, all values of a few per cent., and a few per cent. we can hardly count upon as proving anything, because you must expect in different conditions on different days iron will vary a few per cent. or its physical structure change slightly. If you exclude small changes in the hysteresis values, changes of 5 or 6 per cent., we find that here about three-quarters probably of the samples of iron do not change noticeably, while the rest change by very large values. But that means that really there are two kinds of iron: that kind of iron that changes, ages considerably, and that kind of iron which does not change. These tables are very interesting, although for a different reason: namely, here samples of the same iron have been exposed to different treatment. First, hysteresis loss has been taken as they were received, then after annealing at 800° C.. then after annealing and quenching at 200°, 400° and 800°. Now you compare the different values A, B, C, D, and E and you will find one interesting feature, that in most cases a minimum value of hysteresis constant occurs at B or C. Take for instance the first part of Table III., the first line, No. 1, the minimum is at C, you see, in No. 2 the minimum is again at C, No. 3 is an abnormally low value and does not agree with that In No. 4 you find the minimum, at C. In No. 5 you find the minimum at B. That points to one feature, that there is a certain temperature of quenching at which the hysteresis constant reaches the minimum and that this temperature is as a rule between 200° and 400° C. That accords fairly with my experience that a certain temperature gives the minimum value of hysteresis loss, and if you go beyond that temperature you get higher values, and if you go below that temperature you get lower values again of hysteresis constant. The temperature in most of these tables here seems to have been 200° to 400° C. That is all that I can say about it. Perhaps I might suggest an explanation of this aging: that each sample of iron has a certain value of hysteresis constant at one temperature, a different value at another temperature. The hysteresis constant is a function of the temperature and the physical constitution of the iron also a function of the temperature, and that by maintaining the iron at this temperature for an infinitely long time it reaches this permanent value. Now by exposing the iron to a different temperature, either higher or lower, or by mechanically treating it, or in any way changing the physical constitution so that it does not correspond to what it would assume at a temperature of 60° C., then when we maintain it at 60° C. it gradually will change the physical constitution, the limiting value corresponding to the stable state of 60° C., and that therefore probably we find this aging which may, as some of these tests show, be negative. That is, the hysteresis constant may decrease, although as a rule it increases. It increases because the iron has been brought to this temperature from a higher temperature from annealing, and we know that as a rule the hysteresis constant as a function of the temperature decreases with increasing temperature of the iron. Raising the iron first to high temperature and producing the physical constitution corresponding to the high temperature, and then maintaining it at low temperature it will gradually increase in hysteresis loss until it assumes a value corresponding to this lower temperature. I do not know whether this explanation is correct, but some features seem to point to that. This gradual increase of hysteresis, for instance, with some kinds of iron and almost constancy in other kinds of iron: that is, increase, not uniform, but increase first fast and then slower and slower, seeming to tend to a constant value.

**Mr. I. A. Taylor**:—I was interested in one point Mr. Steinmetz made, that some irons have an increase in their hysteresis loss and others do not. Several of the manufacturing companies have from time to time made claims that they supplied non-aging iron, but in trying to get stringent guarantees about a year ago, it was found that the best that could be done was to obtain a loss of less than about 10% aging per year for two years, which would seem as though, from a commercial standpoint at least, the non-aging variety is still rather difficult to obtain. However, as compared with some of the iron tested by Mr. Ford, 10% per year might be termed extremely non-aging.

It seems as though the more important result of aging has been overlooked—that while the increased all-day losses and the cost of supplying the same have received entire attention, they are really of little more than academic interest; but the fact that the temperature elevation increases in direct proportion to any increase in the total transformer loss, and therefore must increase on account of aging, not theoretically, but practically sufficient to make it impossible for a transformer to carry its rated load after it has been used a few years, is a much more important item.

It is only on this account that it is absolutely necessary commercially to keep the proportion of the iron loss to the total loss down to about 50% or thereabouts. If the iron loss could be raised without fear of dangerous increase due to aging, and the copper loss correspondingly lowered, the better non-inductive regulation would make it possible to use incandescent lamps of at least 15% better economy than are at present possible on alternating current lines. Certainly if transformers can be obtained which will not age practically, it will be a great advance in the interest of the alternating-current central station.

**The Chairman**:—If there are no further remarks Mr. Ford will have an opportunity to close the discussion.

Mr. Ford:—In regard to what has been said about the hysteresis meter, I quite agree with Mr. Steinmetz in doubting the absolute value of these readings. Any one who has worked with a hysteresis meter knows that it is a very convenient apparatus to get comparative results with, but when it comes to absolute values it is quite difficult to calibrate. The samples which came with this hysteresis meter were from Prof. Ewing's laboratory and accompanied by a certificate signed by him, so that they are presumably correct. I might also state that the tests referred to under E in Table III. were obtained with another hysteresis meter. The ultimate calibration and comparison of these meters went back, however, to a certain pair of samples, but they were compared with other samples which were sent with another hysteresis meter, and the two sets of samples agreed quite closely.

The Chairman:—Before relinquishing the Chair, I wish to say that we have the privilege this evening of having with us one of our members from a very distant point, Mr. Peirce, of Johannesburg, where he is the leading electrical engineer of the Consolidated Gold Fields of South Africa, a part of the world that is now of unusual interest to all of us. Mr. Peirce found it necessary in October last to detach himself from the interests at Johannesburg and he is now in this country engaged in finding a solution to some very interesting electrical problems connected with the mines. Perhaps this evening some of the gentlemen present may be able to assist him in regard to any inquiries he may make.

Mr. A. W. K. Peirce:—Mr. Chairman and Gentlemen, I don't know that anything that I can say would be of particular interest. Perhaps, though, you might like to hear what has been done in electrical work in that country which Mr. Pope has referred to so feelingly. I have been out there about four years. At that time they were just beginning really to wake up to the possibilities of electrical power transmissions and other applications. Previous to that date their work had largely been lighting, and the only plants installed were small plants of all kinds, sizes and description and usually rather poor. I know I saw some machines there that carried me back to the very early days as I remember them. They consisted of a field frame and a pair of bearings and the armature, all supported on a timber bed-plate. The only connection between the bearings and the frame was a wooden bed-plate, and there were other freaks of that description. As I say, they have just begun to awake to the possibilities of electric power transmission, and now they use electric power quite extensively. There is one large company there that established a plant for the purpose of supplying power generally along the line. In the first place let me say that the central mining region there, the Witte Water Rand, occupies a stretch of country about 25 miles long and a few thousand feet wide, a long strip of country, and at one end are some coal mines which produce a fair quality of bituminous coal, which makes it, of course, very convenient, and a project was started for establishing a power plant at one of these coal mines, using the waste coal as it came out and distributing the power at high tension along the reef, and that was done. They have a plant of about 2500 K. W. installed capacity and stepping up to 10,000 volts, transmitting over a pole line about 25 miles long. All along the reef, branch lines are taken off at intervals wherever required, and then stepping down to suitable voltage they use it for other purposes, usually for motors. The suburban district of Johannesburg is lighted largely from this plant. The local plant was of insufficient size and they could not raise money to buy any more. This plant is operating well, although they had a great deal of trouble with their insulators from the severe lightning storms that take place during the summer months in that country which proved a little too much for them. I may say that they were not high-tension insulators, such as are used in this country, but simply a large edition of the ordinary porcelain pole-line insulator, and with those they had a great deal of trouble and with some very curious results. They would apparently explode at times and fragments of an insulator would be found up to 40 and 60 feet away from the poles. They are iron poles, and a little moisture had probably crept through a crack in the porcelain and the explosion was due to steam generated. Wooden poles cannot be used on account of the ants. They have a life of only about two years; so iron poles are used altogether, and on this particular transmission, which is the one where high-tension transmission is used, they are up to date. They also use iron arms and with iron pins in the insulators, so that the insulation of the line depends entirely upon the porcelain of the insulator. This line is spiral throughout its whole length, but at the same time it interferes with the telephone system. They have quite an installation of motors at various points, one of 250 H. P. The others are all smaller, and, as I say, they light the town of Johannesburg. The maximum load on that, up to the time I left, was about 1800 K. W. during lighting hours of the evening, and the day load about 1000 to 1200, depending somewhat upon the weather. The only other plant, other than that used for individual mines, is a transmission plant belonging to the Consolidated Gold Fields, they owning a group of mines in the Central Rand covering a stretch of territory of about five miles along that reef. In the center of this territory they established an electric plant for the purpose of supplying power to the various companies in that district which they control. The 10,000-volt plant is—I don't know that I mentioned it—long-distance transmission with 3-phase; this plant also is a 3-phase plant of about 1500-K. W. installed capacity, generating direct at 3300 and transmitting over this five miles of ground. This current is used largely for pumping in the mines, and the high-tension current is carried directly down the shaft in some cases 1500 feet. That is the greatest depth at which we have any pumps installed. They use 3-wire rubber insulated and lead-covered and iron-armored cables, and they have given excellent results. The high-tension current is carried underground and transformed there, and low-tension induction motors are run from the transformer. They have been very unfortunate with one of their mines there in having a great deal of water to contend with, far more than was anticipated, but the electric pumping system has demonstrated its flexibility, as they were able to take care of the unexpectedly large increase in the amount of water necessary to handle with much more ease and less expense than has been the case with other systems of pumping; so much so that they have decided to go in entirely for electric pumping in the newer mines that they are laying out. The favorite pumping installations along the Rand consist of 3-throw pumps usually geared to suitable motors. There are several direct-current installations, but they are not so satisfactory as the induction motor, on account of the dampness, but principally on account of the lack of intelligent operators. Being underground, in a dirty, wet place, they do not get very much supervision, and the men who attend them are not of a grade of intelligence to exercise proper care and judgment in looking after them. On account of the great amount of lampblack always in the air from the kerosene lamps used for light for the mining operations, there is an excellent chance of breakdown of insulation, which very frequently has taken place. With the direct-current machines, also with several installations of induction motors, where they have attempted to use a comparatively high-tension current, such as one installation there which ran at 936 volts or something like that. All of the other mines have only small plants, usually, as I said before, for lighting or for small local transmission, although there are several plants now on order or under way for larger uses. But the principal problem which will arise in connection with the South African mines is that of deep level, on a large scale, probably larger than has been attempted anywhere in this country. The conditions are that the reef carrying the gold dips into the earth at an angle of approximately 35 degrees, and it has proved its permanence so far, both in size and value, to an extent which has warranted them in laying out properties which will demand vertical shafts to intersect this reef at a depth of 7 to 10,000 feet, probably 8000 feet would be the limit within the next six or seven years. Now the problem of hoisting from depths of that kind with a single hoist at the surface becomes very severe on account of the weight of the rope. The rope must be made so strong, in order to support its own weight, that you soon reach a limit that with the amount of power required and the weight of rope and the size of apparatus becomes prohibitive. Therefore the problem of winding in stages presents itself. That is, it would be necessary to install a hoist at the surface which would haul from a depth of, say, 3000 feet; at that 3000 feet install another hoist which would haul from 6000 to 3000 feet, and at the 6000, if necessary, install another hoist to hoist from seven, eight or 9000 feet, as the case may be, up to the 6000, and the hoist must be capable of handling a large amount of ore and at a high hoisting speed, that is to say, six tons and over in each skip, with a hoisting speed of 3000 feet a minute. That is the usual specification. And, as I say, it must be capable of being operated at a depth of 3000 feet. That introduces problems, I think, which other mining industries have not had to face as yet, but it is a very real problem there. Now there are three possible hoisting methods: Steam, which is at once out of the question--well, at any rate, it is inadvisable to take steam down 3000 feet into the ground—then there is compressed air and electricity. One of the latter two will do the work eventually. If it can be demonstrated that apparatus can be built for doing it successfully, electricity has so many other advantages that there is no question as to which will be the power adopted. But that is a country which is about six months away from the manufacturers. That is, it takes a month for an order to go from there to the manufacturers and then three or four months to ship the stuff out. Therefore it is impossible to try experiments there. There is altogether too much at stake. Of course every responsible manufacturer guarantees his output and will make good any defects, but if in the meantime the making good of the defects hangs up a mine which is counted on to make a profit of $150,000 a month or something like that for a period of six months, the repairs on $10,000 worth of apparatus are not of great importance. Therefore, as I say, there can be no experimenting done there, and this is the problem which we have to face, and of course I hope that the developments will be such that electricity will be the motive power adopted. I might say that for this kind of work there would probably be two hoists in each shaft, and there are probably under estimate at present, that is, being laid out on paper, at least twenty shafts; that means quite a hoisting plant altogether. Of course all those shafts are not controlled by one company, but the Consolidated Gold Fields alone has an extent of ground which will probably require about eight shafts, with two hoists of a capacity to do the work that I have mentioned. It is with the hope that I may be able to see in operation in this country something that will approach that kind of work and something that will show that the problem is quite capable of being absolutely met, not partially, that I have come to the United States to see what is being done, and if there is any one here who can give me any information on that subject I should be very glad indeed to receive it.

As regards the general features of power plants there I may say that this large central station, the 10,000-volt plant that I spoke of, uses the waste coal from one of the mines. It was not exactly waste. The dust is sifted out, but they use the fine coal and it is fed into the furnaces by a kind of mechanical stoker arrangement, which is not exactly a stoker, as it fans the coal in. There is a revolving fan, like a paddle-wheel, under which the coal is dropped, about a teacupful at a time, and it sprays it into the furnaces, so that really there is only a very thin fire, and the grate bars consist of perforated iron plates, about eighth-inch holes or something like that, and this coal is spread in on top of it and cleaned by hand. All of the other plants, the general power plants, aside from electric plants, use hand-firing, usually a very poor quality. The coal supply is ample but the quality is rather poor. The ordinary coal gives an evaporation of about six pounds of water per pound of coal with water-tube boilers and under good conditions as to draft and so on. The water-tube boilers are used almost exclusively, except in some of the older plants, which have been equipped for a number of years, where Lancashire boilers are used. As to the engines, I think there are no two alike so far as makers are concerned; some are low, some high, some vertical and some horizontal, Corliss and slide-valve and piston-valve and all the different kinds, I think, are represented there. Compressed air is very largely used, of course, for the rock drills, and I should say that about as much power is used for driving air compressors as anything else, that is, steam power. There is only one instance where an air compressor is driven by an electric motor, and that is the 250-horse power motor I mentioned in connection with the high-tension plant. I think there is a representative of every voltage known to history, from 45 to 200 for lighting circuits, advancing by about from 3 to 5-volt steps. I know of one mine alone that had for lighting circuits one 45-volt circuit, one 60-volt circuit, one 75-volt circuit, one 100-volt circuit, one 120-volt circuit—that was a good commercial machine—and one 200-volt circuit. That was in use on one mine alone. Every time they changed engineers they would change the plant a little. Those were small machines, about 10 K. W. The new engineer would make an addition to the plant and it would have to be something different from what had been there before. That same mine to-day, however, is running from a central station and has transformer step-down stations and always runs with alternating current, and all the old plants have been torn out.

I don't know that there is anything else that I could say particularly in regard to electrical matters, and in my short stay in this country I think I have pretty well exhausted myself on political matters. That seems to be a very general subject here, but if there is any information that I can give about any conditions there, aside from political conditions, I shall be very glad to do so.

THE CHAIRMAN [Mr. Steinmetz]:—I am sure we are all very much obliged to Mr. Peirce for his very interesting account of the electrical conditions in South Africa and the development of electrical industry in that far-away but highly interesting region. I would like to ask him one matter which I did not quite understand:—what was the capacity that these deep-level hoists required?

MR. PEIRCE:—They have to hoist about six tons of ore in each skip at the rate of 2500 to 3000 feet a minute, a maximum of about 3000 feet a minute. It makes something like 800 to 1000 horse-power per hoist and the hoists have got to go down a hole in the ground 5 ft 6 in. x 6 ft.

THE CHAIRMAN:—There is one point that might be of some interest to our members and that is whether Mr. Peirce can inform us what type of machinery is mostly used there. Where do the South African people mostly go to buy machinery? Do they get it from Continental Europe, England or America? In other words, in what proportion about are the different manufacturing countries represented in supplying the South African market?

MR. PEIRCE:—I do not think that there is a manufacturer of electrical machines that has not a machine on the Rand to represent it; but the majority of the machines there, so far as capacity goes, come from either the United States or Germany or Switzerland. Most of the older direct-current apparatus is of English make, but the later plants are almost entirely either American or Continental, that is, German and Swiss. I should say that in actual kilowatt capacity, Siemens and Halske have the greatest capacity of machines represented there. That is, the German firm of Siemens and Halske. But that is partly accounted for by the fact that they undertook to equip this 10,000-volt transmission plant that I spoke of, and of course that is entirely their machinery, both in the station and for the consumers.

THE SECRETARY:—I would like to ask Mr. Peirce about the drifts that follow the reef between the shafts, to what extent they are worked. Of course when they get down to the reef they can work out laterally and follow the reef along. How far do they follow it? The reef runs at an angle and they run down from the surface to intersect it; then, when they strike that reef do they follow it?

MR. PEIRCE:— Then they turn off and sink a shaft of about the same size right down the reef and mine off from this shaft to one side or another. The convenient-sized mining property is about 4000 feet long by 3000 deep; that is, 4000 feet parallel to the reef and about 3000 feet in the direction of the dip, and there will probably be two shafts sunk on that property so as to divide it up approximately equal, sunk near the point where they will strike it soonest, that is, where the reef is at the least depth, and they follow down the incline of those shafts and mine off to each side until they have taken out the entire gold contents of that piece of ground.

THE SECRETARY:—Then do these claims really intersect?

MR. PEIRCE:—No. The mining laws are different from the United States mining laws. According to United States laws a man pegging out a claim on a reef can follow that reef wherever it goes; but according to Transvaal laws he can only mine vertically below the surface that he pegs out. He has a vertical section right down through as deep as he wants to go of a size equal to the surface that he pegs out; so that the people who first started in to mine there, where they started to mine on an outcrop, they thought from experience in other countries that probably the gold would only last to a limited depth and they pegged out a certain amount of ground. When they got down into the reef and found it still holding out to the same value and same width, a few of them had courage enough to believe that it kept on in this same way and they pegged out the ground beyond the original limit, but they did not have quite courage enough, and they only pegged out another thousand feet or so, and when they sunk some vertical shafts and found it kept right on the same value and the same width, generally speaking, subject to local variations, they pegged out still further and further south; that is, the direction of the dip of the earth, south—until now the ground is all taken up for a distance, I suppose, of four miles south of the outcrop, and the mines are divided into regions depending upon the depth of the vertical shaft. The outcrops, of course, started directly on the surface; the first row of deep levels are 800 to 1000 feet deep. Most of the first row are producing mines now. The second row of deep levels vary from 1800 to 3500 feet in depth; that is, vertical depth before striking the reef, and most of those are in a state of development. The shafts have been sunk to the reef and they have been developed along the reef and they will probably be producing within a year or so. And the third are the reefs where the vertical depth of the shaft would be from 4500 to 6000 feet. They are just starting in to sink the fourth row of deep levels, where they will get the 7000 to 9000 feet shafts. They are all laid out, but no work has been done on them other than on paper, but they will be prosecuted as soon as the times comes.

THE CHAIRMAN:—Can any one of the gentlemen perhaps answer the question asked by Mr. Peirce regarding similar installations and problems solved in the United States? Are there any more questions to be asked? I might remind you that the war in South Africa might stop quickly and then then we will not have a chance to have a South African here. They will be so busy that engineers will go from here there and will not come back. If there are no further questions to ask, a motion to adjourn will be in order.

[Adjourned.]

# AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

## —Seventeenth Annual Meeting.—

New York, May 15th, 1900.

The 17th Annual Meeting of the Institute was held this date at 12 West 31st Street, and was called to order by the Secretary at 8 p. m. who announced that in the absence of President Kennelly, and no Vice-President being present, Dr. Sheldon, one of the Managers, would preside.

Dr. Sheldon then took the chair.

The Chairman [Dr. Sheldon]:—The Secretary's announcements are first in order.

The Secretary:—At the meeting of the Executive Committee this afternoon the following associate members were elected:

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| Archibald, Ernest M. | Electric Laboratory Assistant, McGill University, 103 Park Ave., Montreal, Que. | R. B. Owens.<br>L. A. Herdt.<br>R. W. Pope. |
| Bowie, Augustus Jesse, Jr. | Draughtsman, Electrical Dept. Union Iron Works, residence, 1913 Clay St., San Francisco, Cal. | J. A. Lighthipe.<br>H. A. Russell.<br>C. W. Waller. |
| Bryan, Richard R. | Consulting and Contracting Mechanical and Electrical Engineer, 1018 Prudential Building, Atlanta, Ga. | Ralph D. Mershon<br>W. K. Archbold.<br>Thorburn Reid. |
| Cook, Edward Jerome. | Electrical Engineer, Cleveland, Electric Railway Co., 96 Commonwealth Ave., Cleveland, O. | R. N. Baylis.<br>C. J. Field.<br>W. S. Barstow. |
| Davis, Philip W. | Engineer of New England Office, The Electric Storage Battery Co., Boston, residence, 110 Irving St., Cambridge, Mass. | C. A. Adams, Jr.<br>S. E. Whiting.<br>Gifford LeClear. |
| De Muralt, Carl L. | Electrical Engineer, 9 Avenue de la Bourdonnais, Paris, France. | C. P. Steinmetz.<br>A. L. Rohrer.<br>E. J. Berg. |

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| Dyer, Shubael Allen | Manager Supply Department Mexican General Electric Co. Box 408, Mexico City, Mexico. | C. F. Beames.<br>P. H. Evans.<br>M. T. Thompson. |
| Johnson, Chas. E. | Chief Engineer of PowerHouse, Mexico City Tramway, Mexico City, Mexico. | C. F. Beames.<br>Theo. Stebbins.<br>M. T. Thompson. |
| Lafore, John Armand. | Electrical Engineer, The D'Olier Engineering Co., 125 South 11th St., residence, Overbrook, Philadelphia, Pa. | Minford Levis.<br>Jas. G. Biddle.<br>W. M. Stine. |
| Murphy, John. | Superintendent, Power Houses, The Ottawa Electric Co., 620 Wellington St., Ottawa, Ont. | A. A. Dion.<br>T. Ahearn.<br>R. B. Owens. |
| Offutt, Anderson, *B.S.*, *E.E.*, | Assistant Electrician, South Eastern Tariff Ass'n. Care Underwriters Inspection Bureau, New Orleans, La. | A. M. Schoen.<br>E. W. Trafford<br>Jas. A. Wotton.. |
| Robinson, Arthur L. | Electrical Engineer, Southern Railway Co., Box 588 Charlotte, N. C. | A. M. Schoen.<br>E. W. Trafford.<br>Jas. A. Wotton. |
| Smith, Irving B. | Partner, Chas. Wirt & Co., 1028 Filbert St., Philadephia. | Carl Hering.<br>A. E. Kennelly.<br>Minford Levis. |
| Thomson, Clarence. | Examiner, The Patent Office, Ottawa, Canada. | A. A. Dion.<br>T. Ahearn.<br>R. B. Owens. |
| Town, Frederick E. | Superintendent Meter Departments, Potomac Electric Power Co., United States Electric Lighting Co. 706 11th St., Washington, D. C. | C. D. Haskins.<br>C. B. Burleigh.<br>C. C. Haskins. |
| Trudeau, J. A. G. | 329 Kent Street, Ottawa, Canada. | A. A. Dion.<br>T. Ahearn.<br>R. B. Owens. |
| Viehe, J. S. | Instructor in Electrical Engineering, Lehigh University, residence, 28 Market St., Bethlehem, Pa. | W. S. Franklin.<br>J. H Klinck.<br>Ralph W. Pope. |
| Wallau, Herman L. | Electrical Engineer, Brooklyn Heights Railroad Co., residence, 321½ State St., Brooklyn, N. Y. | Sam'l. Sheldon.<br>A. Treadwell, Jr.<br>A. N. Shaw. |

Total 18.

The following associate members were transferred to full membership.

Approved by Board of Examiners, January 12th, 1900.

John Denham, Electrician, Cape Government, Cape Town, S. A.

Approved by Board of Examiners, April 13th, 1900.

J. G. White, J. G. White & Co., 29 Broadway, New York City.

Approved by Board of Examiners, April 20th, 1900.

Robert Stuart Stewart, Westinghouse Electric and Mfg. Co., Pittsburg, Penn.

George William Hubley, Electrical Engineer, Louisville Electric Light Co., Louisville, Ky.

William George Toop Goodman, Electrical Engineer, Tramway Construction under Public Works Dep't., Sydney, N. S. W.

Eugene Russell Carichoff, Electrical Engineer, Sprague Electric Co., Bloomfield, N. J.

John Sedgwick Peck, Electrical Designer, Westinghouse Electric and Mfg. Co., Pittsburg, Penn.

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The Chairman:—The appointment of tellers to count the ballots will be next in order. I will appoint Mr. Townsend Wolcott and Capt. Samuel Reber as tellers of election, and they may choose such assistants as they need to help them in counting the ballots. As Proxy Committee I will appoint Mr. William Maver, Jr. and Mr. C. O. Mailloux.

The next business in order is the reading of the reports of the Secretary and of the Treasurer.

The Secretary:—Before the ballots are counted I think it is proper for me to make an announcement as to the course of procedure that has been followed. For the first time since 1893, as you are aware, there has been a certain amount of competition in the campaign, and in carrying on the work of my office I have been guided as far as possible by the Constitution, and previous rulings of the Council. The rulings of the Council in 1893 were, that a member had the privilege of recalling his ballot where it was sent in at any time previous to the election. Another ruling was that where two ballots had been cast by any person, the last ballot cast should be counted and the first ballot thrown aside. It has been usual in all elections to cast aside those ballots which did not bear upon the outside envelope the name of the sender. This of course is necessary, in all events. All ballots turned over to the tellers have been checked off by the membership list, and are correct, barring clerical errors. This will relieve the tellers from the duty of checking off those ballots, if that is entirely satisfactory to the meeting. It should be understood that all apparent irregularities should be settled by the outside envelope, as after the envelope is opened and the ballot taken out there is no way of distinguishing one from another. Therefore if the tellers observe anything that is irregular they will please report it to the Chair.

The Secretary read the Report of Council for the fiscal year ending April 30th, 1900; together with the Reports of the Secretary and Treasurer; accompanied by a statement from the Cashier of the Mercantile National Bank, stating the balance to the credit of the Institute.

[See pp. 213-216 April issue.]

The Chairman:—The Executive Committee of the Council inspected these reports of the Secretary and Treasurer and approved them.

**Mr. Steinmetz**:—I would like to ask the Secretary how many copies, approximately, of the Standardizing Committee's Report have been sold.

**The Secretary**:—They are sold at two prices; they retail at ten cents and wholesale at five cents; and the receipts from them are $35.80. So probably there have been, I suppose, between 800 and 1,000 of them sold.

**The Chairman**:—We will now take up the paper of the evening, "Experts and Expert Evidence," by J. E. Hindon Hyde, of the New York Bar.

[See p. 199, April issue.]

## DISCUSSION.

MR. EDWARD P. THOMPSON:—I wish to make a few remarks on the experts' side of the question. In regard to the matter of honesty, of course that is an enormously important matter, and yet a comparatively trivial matter. There are plenty of people who are honest. What we want is more competency. That is a scarce article. I remember one expert saying that he did not like to be an expert. I said, "How is that? You have served very often." "Well, I don't like it. I find clients all expect me to tell lies, and I don't like to disappoint clients." But that same expert is one who was quite popular, and is the one whom lawyers prefer. He is both honest and competent. A person is the best expert who is not only honest but also competent. You must keep those two things together. Honesty without competency amounts to nothing. Competency without honesty amounts to nothing. It is just like an invention,—a combination of two things. An expert must be a combination of these two things. In the first place, he ought to be able to distinguish between what is an invention and what is a device. Of course he must not hurt the feelings of the judge and the lawyers, and tell whether the device infringes or whether the two are identical; but the expert must *know*. He need not declare whether there is infringement or not, but that is what he should tend to understand from the time when he begins to examine the papers, to the end of the case; and if in examining, he is very doubtful as to whether his testimony will be beneficial to the client, he should tell the client that, and let the client know his honest opinion.

As to this matter of the value of an expert,—experts are witnesses. When cases can be carried on in court without witnesses, then patent suits can exist without experts.

On the subject of an expert being employed by the court, as a substitute for employment by the client, of course that would be worse than it is at the present time; but the suggestion as interpreted in another way, I fully agree with, and that is that in addition to the experts employed by the different parties there should also be an expert engaged by the court, because such an expert can greatly assist the judge. Otherwise the judge is in a state of confusion. I happened to be acquainted with a certain judge who decided a patent suit. He knew nothing about electricity. He knew no more about electricity than we are supposed to know about Greek—not as much. Such a judge cannot understand experts on opposite sides. He knows not which one to believe.

The expert has come to be, of course, a professional man. If there are fifty claims, experts must know what the difference is between the first and fifteenth, or the first and twentieth, and so on. They must know the exact shade of difference between those claims.

As to incompetent evidence there is an instance where testimony was given in the Morse case; they actually brought in as alleged *bona fide* evidence the fact that dots and dashes were scratched on the walls of a prison by two prisoners, who could not actually see each other, the dots and dashes representing the alphabet—that was submitted in a *bona fide* way into court to prove that that was anticipation of the Morse telegraph system. What is the difficulty, and why is there anything strange about this? There is really nothing unusual; it only happens to be an important case in the courts, and happens to be an important invention, and happens to be an important inventor, and so it strikes us as unique. Similar blunders occur now. An expert often distinguishes between the elements of an invention, instead of the invention as a whole. An invention consists of a combination. Laughing gas would not be old simply because its elements, nitrogen and oxygen are old. Testimony is wrongly taken in regard to priority of the *elements* of the invention instead of the invention itself as a combination. You have to distinguish what is an element and what is the whole invention.

In a certain patent suit, there was a photograph which apparently illustrated the same invention as the model that was put in by the other side, and was about to be accepted, and stipulated upon, that it would not be necessary to bring the model represented by the photograph,—that the two were identical. But the expert insisted upon having more satisfaction than that, because the photograph looked suspicious. A photograph, you know, can make a circle look like an ellipse, for example. It makes things in the background appear closer than they really are. The photograph had been taken to make the two things look alike and yet they were not. So the expert must know the tricks practiced by the other side. They may not be intentional tricks; you need not accuse a person of being dishonest, but things come up of that kind and if a person is not aware of what is going on, he may get caught himself.

The gentleman who read the paper spoke of one expert who took seventeen days to answer one question. Probably that was the fault of everybody, the fault of the expert and the fault of the lawyer and the fault of the stenographer and the fault of the opposing lawyer, and the fault of so many patents being put in, and faults all over. Everything was wrong. Of course the solution that was given by the author of the paper was the proper one.

MR. JESSE M. SMITH:—I think if we were to hear another lawyer on this same subject we would get very different views, just as different experts will have different views on the same subject. If there were not two views by different attorneys, and two views by different experts, on a given subject, there would be no litigation—there could be none. Now it is the function of the court to determine which of these two opinions is more nearly reasonable, which is right, as the court sees it; because the court is the one authority that can cut the "Gordian knot". It is not for the experts, nor for the attorneys. The first court may be wrong, but then the case will go to the appellate court, and two appellate courts may see it differently. Then the Supreme Court of the United States comes in and says what is right and what is wrong, and nobody can go behind that.

Now as to what the duties of an expert are, and what the duties of an attorney are in a case. That is a question which is also debatable and which will be debatable to the end of time.

On the question of whether the expert should sit with the judge, or whether the facts can be brought out better by experts hired by the two sides, I lean to the idea of the experts hired by each side, and let those experts be honest and competent, and let them sift the facts, each one presenting his facts as he sees them, to the best advantage; and let the court decide which is right and which is wrong.

Now as to the question of bringing an expert into a case without preparation. It frequently happens. The client has not money enough to pay, or will not pay the expert to properly investigate the subject before he goes into the case. The honest and competent expert will not go into a case unless he has prepared himself in advance; and he is entitled to the pay that is necessary for that preparation; and if after he has fully examined the case he says to his client, "I am not prepared to take the position that your attorney wishes me to take," then he should keep his retainer, and be paid something besides; because he has taken the confidence of the client, as well as the attorney who has put the papers and the facts into his hands, and he is in duty bound not to take the other side of the case under any circumstances. Therefore he is entitled to the full amount of that retainer and he is entitled to compensation for every hour that he has put on to the case, because he has done it honestly. He has earned it. I fully agree with the view expressed by Mr. Hyde, quoting from an eminent attorney, that when he has been once on one side of a case he cannot go onto the other side. It makes no difference whether his client has failed to retain him on a yearly retainer, or in any other way; if he has once taken the confidence of a client he is bound by common honesty to stand by that side, and not take a retainer on the other side, and risk breaking down his former client's case, by divulging some secret or confidential knowledge.

Now in regard to this question of a man taking seventeen days to answer a question. That applies to me.

MR. HYDE:—I think not. You are not the gentleman I referred to at all.

MR. SMITH:—I am going to say that it applies to me because I have frequently taken that amount of time to answer a single question, and I expect to continue in just that way, and I will tell you the reason why. In the majority of cases in which I have testified, for the most competent attorneys in this country, I have rarely been asked on direct examination more than six questions. The first one, "What is your name, age, residence and occupation?" The second, "What is your qualification?" The third, is some insignificant question. Then come the crucial questions: Fourth, "What is the structure set forth in the patent in suit and recited in claims 1, 3 and 5?" Fifth, "What is the state of the art in regard to those claims?" Sixth, "Compare the patent in suit with the state of the art." Now those questions sometimes are condensed into two or three, and with design. It is done, where a competent attorney and a competent expert come together, after a very careful study of the case by the expert, and a very careful consultation between the expert and the attorney, so that the expert knows exactly the position which the attorney takes, and the attorney knows exactly the position which the expert takes, and they are working in unison. When that is so, all that is necessary is a single question to bring out the facts in regard to the case. Then another question is, "Compare the patent in suit with defendant's structure." This question may take several days to answer, in connection with the prior art; but when those questions are asked and answered the direct testimony is finished. Then comes in the cross-examination, and that takes longer.

As to the question whether two men can be honest and be of different views on the same subject: I was in a case recently where the question turned upon whether a rheostat was an electric heater; that is, whether a rheostat could be cited properly against a patent for an electric heater. A coil of wire in which a current of electricity is passing is a rheostat, and it is also a heater. Now where does the coil of wire cease being a rheostat and begin to be a heater? You cannot put a current through a coil without having resistance, and you cannot put a current through the same coil without getting heat. Therefore a rheostat is a heater. But experts will talk at length on that little difference. They will say that a rheostat cannot be cited against an electric heater patent, and *vice versa;* and in that way a large amount of time is lost and a large amount of money is wasted, in talking about insignificant facts, when it is simply an application of Ohm's law.

It is said by the author, and very properly, that an expert should not get mad, should not say things on the record that do not belong there. I perfectly agree with him. He ought not to get mad, but it takes a saint not to get mad at the questions that are sometimes put to him. The expert who has had the most experience gets the least mad; but he gets awfully mad in getting the experience. Sometimes, after a long direct examination, the first thing that the attorney on the other side does is to put in a lot of objections, in which he attacks the honesty of the witness, his ability and his sincerity, and suggests everything that is disreputable; and it is done evidently with the intention of getting at cross purposes with the witness from the beginning, and getting him mad and getting him to say things that he would not say in his sober senses. It is necessary sometimes to know the tricks of the attorney for the other side in order to meet them. An expert is liable to confront some attorneys (fortunately there are very few of them) who are dishonest enough to pursue that kind of a policy; but I wish to say here, that in all my experience with the patent bar, not only in this city but in the West, where I have had more experience than here, a finer set of high-grade gentlemen does not exist than the better practitioners of the patent bar.

Mr. Charles L. Clarke:—As the author says, the public derides expert testimony. Naturally there is considerable dissatisfaction with such testimony on the part of lawyers, and experts themselves are disgruntled more or less, because of this state of affairs. I think whatever disfavor experts meet with is, in greater part, due to themselves. It makes no difference what pressure may be brought to bear from the outside to mislead an expert, or to induce him to depart from telling the truth and telling it straight, whether in matter of fees, or zealousness for clients, or the prodding of lawyers, an expert is not obliged to be governed thereby, if it does not lead him in the line of truth; and if he does not follow in that line, of course he injures his reputation. An expert ought to be upon a very high plane, practically upon the same plane as the court, only the expert does not decide the case. Therefore, when an expert does fall, the fall is great, and the noise that is made thereby is loud and spreads afar. A very few experts who do not go just right can bring discredit upon the whole craft.

I was impressed with the correctness and importance of that part of Mr. Hyde's paper in which he speaks about the improper tendency of some experts to discuss and explain, in testifying, their interpretation of the law. In that connection I would say that we experts sometimes do, so to speak, take the law into our own hands. I have done it. I am getting over the bad and improper habit, or at least trying to, of expressing opinions upon the question of invention. Quite frequently that habit on the part of experts has been severely criticized by the court. Of course an expert has no right to express an opinion as to whether to do a thing did or did not require invention; that is a question solely for the court to consider and decide. Then, again, experts are making an ever-increasing use of that mysterious and well-nigh omniscient individual, the "skilled mechanic", to help make out their client's side of the case. They very often express the opinion that the skilled mechanic would naturally, as a matter of course, have done this and that—the very thing described in the patent which is in suit—thereby practically testifying that no invention was required. It is not right for the expert to make any use of the skilled mechanic other than to cite all the cases that may be necessary as bearing upon the matters in controversy where mechanics have been known to do certain things. The expert may approach just as close to what has been done in the patent, by explaining what mechanics have done, as he possibly can. Then it should be left for the court to say whether, in view of what had been done, a mechanic would, without invention, have done the thing which is in the patent in suit.

In regard to the question of the employment of an expert, I am rather inclined to think, after a full consideration of that matter myself, and discussing it with a number of prominent lawyers, that the best way for an expert to prevent misunderstandings, and avoid possible loss of reputation, perhaps unjustly, is to charge a reasonable retainer to cover a preliminary examination of the case, which retainer estops him from acting for the opponent of the party first approaching and retaining him, and is sufficient, in some measure, to reimburse him for the labor of such examination in case it is found that he cannot be of practical use to the party who has retained him. In that way he gets something for his work. Of course he runs the possible risk of being deprived of a large amount of work by not acting for the other party, in case he finds that is the party in whose case he believes; but nevertheless he had better lose that chance rather than run the risk of losing his reputation for fair dealing by accepting a retainer from the party who first approached him, and getting more or less knowledge of their secrets, and then going over to the other side. I am glad to see that the author agrees with me in this view.

Mr. Hyde has suggested the advisability of the court having its own technical adviser. I also think it might be well for the court to have such an adviser, but I do not think that the litigants should be debarred from having their own experts, because the court might not select a person who would be as competent to expound the technical and scientific features of the case as other available persons known to the lawyers of the litigants, and therefore an injustice might be done, although undoubtedly the expert adviser of the court would always be competent to review the testimony of the experts for the litigants. I think that the employment of a court adviser might tend to shorten the time consumed in taking testimony, and help to lessen expenses. Would it not be the fact that experts for litigants, knowing that an expert appointed by the court was to review their testimony, would be shorter, sharper, and more direct, and not wander off into the fields of conjecture? And then again would not the lawyers trim the case down, in view of that very fact, and not lumber the record with unnecessary depositions and other irrelevant matter?

In conclusion I might say that lawyers can assist in raising the standing of the craft by relegating to the rear experts who are known to be *shifty* and *adroit*, in the invidious sense of those terms.

We have with us this evening a gentleman who is known to you all, at least by reputation, as an expert of long experience and honorable standing, and from whom I am sure you would like to hear a few simple and direct rules for your guidance. He is, I believe, the Nestor of experts. It gives me pleasure to introduce Mr. Edward S. Renwick.

MR. EDWARD S. RENWICK:—I was asked to come here this evening to listen to an address by Mr. Hyde, and came and have heard it with great pleasure. The paper is so thorough and exhaustive that it is difficult for me to add anything on the subject; but I may say a few words, and from my long experience, running back to the year 1850, and having been engaged probably in a greater number of cases than any man who ever lived, it may possibly be of advantage to those who are now here. I may say from my own experience that the first requisite of an expert, in my opinion, is absolute honesty. He must be honest not only in stating his opinion, but it is his duty to be honest in answering whatever questions may be put to him as directly as possible, even when those questions which are put to him may, in his view, militate against the side by which he is employed. You will find invariably that unless he does that, his own opinion becomes of less and less value the longer he continues in that course. There is no reason why he should not answer questions in a straightforward way, because if he does not answer them, somebody else certainly will, and if it is a fact that is important in the case it will infallibly come out, and the very fact that he has in any way avoided a proper answer will militate against the value of his opinion as to other facts. I recollect well a case in which I was employed with another expert; when a hypothetical question was put to him, as to whether a certain hypothetical machine would or would not infringe the claim of the patent. He wished to avoid the question, and when the question was repeated to him in a number of ways, a number of differerent times, he avoided an answer. When lunch time came I said to him, "Why on earth didn't you answer directly? It is plain enough." Said he, "Do you suppose they have got such a machine on the other side, and it is old?" I said, "What matter does it make? There is no question about the fact. You know as well as I do that such a machine would involve the patent and you may as well answer it directly. And," I said, "aside from that, there is not one chance in a thousand that they have got such a machine as an anticipation." So immediately after lunch, when the question was put to him in a different way, he answered it directly. Subsequently it turned out that no such old machine had existed.

There is another matter which I think is very important for an expert, and that is that he should thoroughly study his case. It is impossible for an expert to study his case too thoroughly; and unless he goes into the case with a thorough knowledge of every part of the specification, and how each part of it may affect the construction which must be put upon the language of the claims, he is not really thoroughly competent to be examined as an expert in the case. I have known many experts in my time, and I have known a number who relied upon their quickness, as they thought, when they entered into the case, in learning everything that was necessary; and that they would know more than the lawyer on the opposite side, and perhaps more than the expert on the opposite side; and that they could go on with the case without a thorough study of it beforehand; and I have never known a case where such a man succeeded. He went on for a few years and then was dropped.

There was one matter spoken of by Mr. Hyde upon which I do not exactly agree with him, and that is whether an expert who has been engaged by one party and who is unable to act for that party, can be employed for the opposite party. I think it highly improper that he should do so in that case. Another case may come up in which the circumstances are entirely different, and in which he might act; but in that case he certainly cannot act, and he cannot act in any case in which the grounds, the conditions, are exactly the same; because although he may think to himself that he can keep a straight path between what is right and what is wrong, it is hardly possible in human nature to do so, and the better course is to refuse to act for the opposite party.

There are some other questions on which I might perhaps say a word. As to the question of an expert being called by the court; however an expert may be employed by the court, or may become a member of a court, it would not be possible for him to thoroughly understand the case, unless he had the views of the other experts on the subject. An expert usually does not, in one sense make the case, but he stirs up the case so that you are able to get at the truth, and the stirring up of the case is best done by having two discuss the matter on opposite sides. For more than twenty years I have had an opinion that an Appellate Court should be created at Washington for the purpose of trying appeals in patent cases, especially for the reason that now we have I think eight circuit courts without any appeal from them; and we have cases already in which in the different circuits the courts have come to exactly different opinions. Before the present system, we did have in the Supreme Court a court of last appeal. We ought now to have an Appellate Court sitting at Washington for special appeals in patent cases; and in such a court, I have always contended that an expert should be a member of the court for the purpose of instructing the court confidentially; for the court cannot possibly call on the experts of either of the opposite sides for tha purpose, because the expert on one side might be biased in one direction and the expert on the opposite side in the other; therefore I think if such an Appellate Court is created an expert should form a member of the court. In the State of New Jersey, in which I live, we have courts composed in part of lawyers and in part of laymen. While the lawyers as a general rule overrule the laymen, there have been cases where the laymen overruled the lawyers. There have been cases where the laymen were right and the lawyers were wrong. It might be the same in patent cases. There is one other matter, and that is with reference to experts testifying on opposite sides. Two honest experts may in a patent case testify honestly directly opposite to each other, the reason being this: that in every case the opinion of an expert is based upon his understanding of the invention. Now two persons having opposite characters of mind may form two different views of an invention, and may honestly do so; and there is no reason under such circumstances why each expert may not be thoroughly honest and may not testify honestly. It is the duty of the court in that case to determine which particular view of the experts is the proper one.

As to an expert giving his own views of the law in a case, there is no doubt about the fact that it is the duty of an expert to express no such view unless he is called upon. I regret to say I have in some cases been called upon by lawyers to express a view on the law in a case, but it has been a very rare circumstance, and I never volunteered it in my life.

Experts have been known to take without study the view of the patented invention formed by the counsel in the case. I have known some experts who were engaged by counsel for the reason that they were ready to take any view of the invention which the counsel thought expedient to win the case; and I have seen such experts fail on cross-examination and get out of the business in a few years. I have had counsel ask for my understanding of a case after I have studied it; and, when he found that it was unfavorable to his client, to say, "the exigencies of this case require" a different view, which I knew I could not conscientiously maintain. In such a case I have said that he must find some other expert, and have not been called upon to testify. Subsequently I have learned that the counsel found no difficulty in getting an expert who would testify as the counsel wished, without regard to any opinion that the expert might form upon a study of the case. Such experts must have had the happy faculty of believing that the party on whose behalf they were engaged was always right, a condition of mind that was impossible with me.

**Mr. Clifford E. Dunn**:—Mr. Hyde has certainly given us a very interesting paper on the rights, duties and characteristics of an expert. In view of the fact that he has had so much more experience at the bar than I have, I am somewhat backward in saying anything which would seem to be contrary to his expressed views, but there is one matter which, it appears to me, he has not taken into consideration at all. The paper consists of practically two parts: first, a statement of the present conditions, and a concession that they should be better; and, second, the way of producing that betterment; and it seems to me the two tend to an idealization of the expert. Now let us see what these present conditions are. Our procedure in a patent suit is to first file our pleadings, get those straight; then the complainant proceeds to take his testimony. He gets his expert witnesses and they testify to the scientific facts, and their deductions from them; and then those facts are almost invariably contradicted by the expert witnesses on the other side. The records are printed and together with the briefs of the opposing counsel are submitted to one of the circuit court judges. Now who is this circuit court judge? In nearly every case he is an able lawyer, but in nine cases out of ten, I think I can safely say, he is a man who has practically no scientific knowledge whatsoever, and this is so for very obvious reasons. Circuit court judges are chosen for their legal qualifications, not for their scientific, as the patent cases tried before them represent but a small portion of their work.

Notwithstanding that, many of these cases involve questions of the most intricate kind. One case which Mr. Hyde mentioned, Tesla *v.* Scott, involving three or four of the Tesla alternating-current motor patents, was decided by Judge McPherson, of Pennsylvania, a few months ago. Judge McPherson before hearing the case admitted that he was ignorant of what to us seems to be an elementary fact, that a current passing through a coil of wire surrounding an iron bar makes the bar a magnet. One of the most elementary principles of electricity he knew nothing of. Yet he was called upon to decide the right to the inventions shown in those patents. Is it any wonder that he, in his opinion, quotes the complainant's brief almost word for word, and then modestly says that he advances the opinion for what it might be worth? It seems to me that the remedy for present conditions is not wholly within the scope of the experts themselves. They are called upon to state their understanding of certain scientific facts and their deductions from them. As Mr. Hyde says, they present them in the most favorable light for their client. That is only too true, and is it reasonable to suppose that a layman can go to work and sift these dissertations, dealing with the most abstruse questions, and find the real wheat and discard the chaff in every case? I think it hardly likely. Mr. Hyde leads up to the statement, or the inference which I drew from his paper is, that by experts increasing their honesty—I prefer to call it frankness—their present unsatisfactory standing will be bettered to a certain extent. There is a very obvious argument against that proposition, it seems to me. We will assume that the body of experts are raised to this ideal plane of perfect frankness; a suit is brought, and the defendant or the complainant comes to an expert and seeks to employ him. The expert looks into the case and finds some weak points. The employer must assume that when the expert goes on the stand he will be perfectly frank and deal frankly with those individual points; and it is all right that he should do so; but is it human nature that a litigant who has probably been forced into litigation, and, although he may have the wrong end of the case, be bound to carry it through—is it human nature that he is going to employ a man to help him lose his case by explaining its weak points? It does not seem so to me. There are two ways, both of which have been already mentioned this evening, of getting around the difficulty. One is the method of having a court expert to oversee the transactions, and to confer with the judge, still having the experts employed by the litigants. The other is the system which is now in use in Germany, but which I think less favorably of than the other one. Over there the litigants file their pleadings substantially as they do here, except that they are much more full; details of infringement, and such things, are given. Three sets of questions concerning the matters at issue are then drawn up, one set by each attorney and another set by the court. These three sets of questions and the pleadings are submitted to the two experts selected by the court, who have no knowledge as to who the parties are, and these experts render their opinion on the questions at issue. Then it seems that their opinions are in turn referred to another expert, also appointed by the court, and also ignorant of the particulars of the litigation; who, in conjunction with the court, renders the final decision. And I have been told by an expert here in this city that a very curious result has grown out of that. Some cases over there are of such wide notoriety that the experts when made acquainted with the facts could not help knowing who the litigants were. To prevent that they have sent those questions for decision to experts in foreign countries: and I understand one expert in this city has had some of those cases for final hearing before him. He renders his opinion and sends it to the court.

MR. ELIAS E. RIES:—There were several interesting questions brought up and partially answered in the paper of Mr. Hyde, and in the discussion following. There is, I believe, a better remedy which suggested itself to me, and one that might possibly overcome the difficulties that have been cited. Presumably, of course, the object of expert testimony is to get at the truth, the exact truth, of the situation on the technical side of the questions involved. That this object is not always attained is obvious from what has been said here to-night. It stands to reason that there must be, assuming the entire honesty of the experts, numbers of instances where the expert can decide with equal facility and without any pricking of his conscience, on either side of the question at issue with equal truth. For example, we have had a case cited this evening involving the difference between a rheostat and a heater; that is to say, at what point a rheostat became a heater; and there are any number of questions of similar delicacy, differing only in matters of degree and often to a very slight extent, which, under existing practice, are quite naturally dwelt upon and defined by experts in favor of the side which employs and pays them for their services. Now, in contradistinction to current practice, I believe it would be possible and quite feasible to provide a plan whereby each litigant shall have the right to nominate his own expert, that is to say, to select some expert whom he believes to be best qualified, by reason of his familiarity with the art, or of his special knowledge of the matter involved, to decide the questions in the case which pertain to his particular patent, or who is familiar with the questions involved to a greater extent than some other expert might be. This much being accomplished, have it arranged that the pay of those experts shall be jointly borne by both litigants, or charged to the costs of the suit; that is to say, let it be understood that the experts are not so much in the employ of the litigants themselves as in the employ of the court, since it is their purpose to so answer questions as to bring out the truth. Then, if deemed desirable, let the court itself appoint an expert, or rather let the two experts of the litigants appoint one, who will act as umpire. There would thus be a sort of board of arbitration of experts, two of whom nominally represent the litigants in the case, and these two selecting a third, who will pass finally upon any undetermined or disputed question that may come up, and who will report to the court itself. In that way, an expert, knowing that he is directly responsible to the court, will in nine cases out of ten seek to do justice; that is, he is perfectly free to act in the interest of pure truth, and will have no motive in twisting or straining technical points in favor of one side or the other against his unbiased judgment. It seems to me that a plan of that sort would be advisable and conducive to quicker, more expeditious and more equitable results than are obtained by the present system of paid experts on both sides.

MR. WM. MAVER, JR.:—We have all been much interested in hearing Mr. Hyde's paper and in my mind there is no doubt as to the lasting value of this paper.

It may at first be thought that inasmuch as the number of electrical experts who now make a specialty of testifying before the courts is comparatively limited, therefore, the paper may not apply directly to a very large number of persons. It is also probable that the number of such specialists may gradually diminish because of the diminishing demand for their services; owing largely to the fact that in many cases the differences between the lions, and the lions and the lamb, which accrued to the benefit of the expert, do not now so frequently occur, the lion and the lamb having settled many of their differences and now lying down together; the lamb usually inside the lion. But, of course, there will always be a greater or less demand for the specialist, and to him the suggestions in Mr. Hyde's paper will be very welcome. Furthermore, it is very rarely that at some time in his experience the regular electrical engineer is not called upon to testify as an expert, and to him the points in Mr. Hyde's paper will be, I might say, invaluable.

I should like to say briefly something on the side of the expert with regard to some of the points mentioned in the paper.

With reference to the bias of ratio of fees to services. It is, I think, doubtful if one expert in a dozen gives the question of his fee a moment's consideration while he is studying the question at issue or while testifying. The natural expert is, so to speak, a soldier of fortune (not a "mercenary"), and his only thought while he is testifying is to protect and advance his client's interests and also to enhance his own reputation. I do not for a moment imply that before and after his direct work in a case the question of fees is neglected by the expert. I have myself handed large fees, for services rendered, to some of the most noted of electrical experts in the world, and the fees were received without any visible signs of compunction.

From personal observation I quite agree with Mr. Hyde, that in the great majority of cases justice is done in a case, finally.

Mr. Hyde advises the expert to give categorical answers to questions so far as possible, and that an expert should answer each question by itself as it is presented, and not concern himself with what he may have previously said in that or other cases. If the expert were sure that the opposing lawyer would not take advantage of apparent inconsistencies, he might disregard previous statements, but that is too much to expect, I fear.

Mr. Hyde also appears to suggest that the expert should volunteer information that may be prejudicial to his own side, and asks if it would be right to say that an engine worked, but omit to say that it would only run an incomplete revolution. This is a case where an expert would most likely give the categorical answer which lawyers seem so much to desire. The next question would doubtless elicit the information as to the incomplete turn of the engine (unless the opposing lawyer were very derelict), the facts would thereby be brought out, and the expert would avoid the charge of having volunteered the unfavorable testimony; if it was unfavorable.

I recall an instance where an expert witness in a very important suit for infringement of a patent, while in the middle of his testimony in the case, discovered a hitherto unnoticed action in the apparatus concerned in the suit, which he believed would upset the most important contentions of his side, should the said action become known to his opponents. It required careful answering thereafter on his part to avoid giving a clue to the newly discovered action, but he succeeded. Would it be said that this was a case where the expert should have shared his newly acquired knowledge with his opponents, to the great injury of his own side. He has never felt so. Yet it might be assumed from Mr. Hyde's remarks, if I do not misunderstand him, that strict honesty to the court would have required that the information should have been volunteered, regardless of duty to the employer's interests. This is doutless an instance where, as Mr. Hyde states, "each expert must judge for himself."

The occurrence of cases like this, however, emphasizes the need of experts for the court, who would by reason of their unbiased connection with the case be of great utility in bringing out all the facts possible.

I fully agree with the author of the paper in respect to the value of testimony based upon personal, practical knowledge or experiment. I recall another instance in the case of a suit for damages in which it was seen from the drift of the complainant's case that the point would be made that if a copper wire of an arc-light circuit came in contact with the iron span wire of a trolley road and found a "ground", it would be the copper wire, and not the iron wire, that would melt. On consideration it was seen that there were three reasons why the iron should be the first to separate. Namely, the higher electrical resistance, the lower heat conductivity of iron, and the fact that the iron wire was sustaining two trolley wires, while the copper wire was hanging loosely from a pole on one side of the street to the lamp-post on the other. Before going on the witness stand the expert made tests which showed that under the conditions stated an iron wire would be the first to separate, and he was prepared to so state if the question as to actual knowledge had been put to him, but it was not. The complainant's expert witness, however, under cross-examination, and after some fencing, admitted that theoretically the iron wire would first separate.

I also quite agree with the author in his remarks concerning the temptation to turn unwise questions of an opposing counsel into ridicule, and that it is much better not to yield to this temptation. And also, where an opposing lawyer asks a question hurtful to his own case, not to harp too much upon it. It is fair to assume, as Mr. Hyde points out, that the court will be quite as acute as the witness to observe the slip. Not very long ago a question of this nature was put to myself, and in my answer I emphasized the slip in addition to giving an answer to all that the question called for. My cross-examiner had been studiously courteous throughout, and I felt that my superfluous remark was a poor return. By consent that portion of my answer was stricken from the record and, although no remarks were exchanged off the record, it was evident that the act was appreciated.

In the discussion reference has been made to the length of time taken sometimes by experts to answer questions, and ten or more minutes was cited as an unnecessary time for deliberation upon a question. I have on more than one occasion taken longer time than that to deliberate on an answer, and if the same questions had been submitted to me outside of the case I should have taken several hours for consideration of them.

The fact is that experts are frequently called into a case, and are expected to testify on very short notice. Consequently, the time for the proper investigation of a complicated case is often very limited, and it therefore seems reasonable that a witness should be given time to consider his answer in all its bearings to a question that may have brought up an entirely new feature of the case. Furthermore, it is very likely that an expert frequently takes longer to frame his answer than to reach a conclusion as to the purport of his answer.

There is a matter to which I would call attention, namely, the employment of an expert to consult with counsel while he is cross-examining the experts of the other side. It has seemed to me on reading over testimony that the advice of an expert at certain times would bring out evidence from the opposing expert which otherwise must be brought out on direct examination by other experts.

It seems to me also, from personal observation, that the matter of recording expert evidence that is sometimes followed in trial cases, as in damage suits, should receive the attention of lawyers. The editing of this evidence is usually left to the court stenographer, with the not uncommon result that so far as any real utility of the evidence to the appellate judges is concerned, it might as well not have been given. .

MR. HYDE:—In response to Mr. Thompson and Mr. Renwick, I regret that there should seem to be, as it appears, any ambiguity in the last paragraph but one of my paper. I said that I looked forward to the time when the court would have its own expert as an adviser, and while then there may still be that "conflict of evidence" which is now so usual, it will do less harm, meaning, of course, that the court's expert will guide the court between the views of the opposing experts. I thought that the words "conflict of evidence" clearly implied the employment of experts by the parties as now, and I certainly contemplated such employment. If, as assented to by Mr. Renwick, it would be a good thing for an Appellate Court to have its expert, it seems to me just as wise for the lower court to have one also.

With regard to some of the views expressed by the other gentlemen, I desire to call their attention to the fact that it seems useless to try to defend the present system, and the manner of testifying frequently employed by experts under that system. The courts and public attack the experts, with justice, and the remedy does not lie in a counter-attack on the judges, nor in a defense of the present system, but in an effort to reform that system and the conduct of the experts themselves. Other papers could, of course, be written on the evils of the system, and on the qualifications of the judges, but the subjects would not be germane to that of the present paper.

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[The Executive Committee has authorized the incorporation in this discussion of the following communications received since adjournment by the author and which are printed in the order of their dates.]

DISTRICT COURT OF THE UNITED STATES.
CHAMBERS OF THE JUDGE.

Utica, N. Y., May 21, 1900.

MR. J. E. HINDON HYDE,

My Dear Sir:—I took pleasure in reading your paper on "Experts and Expert Evidence." I agree in the main with what you say. Your suggestion as to a technical adviser for the judges is theoretically correct, but as a practical proposition I deem the objections almost insurmountable. Perhaps some practice analogous to the "Trinity Masters" in admiralty might be adopted. Even in this country it frequently happens that admiralty judges, where a technical question of navigation is presented, invite some expert navigator to sit with them during the trial.

Considering the "expert" question solely in relation to patent causes I think the principal difficulty is in the manner such causes are tried. If they were tried before an officer having power to rule upon the evidence, it is safe to say that half the evidence now presented to the court would be excluded.

But here, again, we are met by an almost insurmountable barrier. With the present judicial force it will be simply impossible to change the present system. In the meantime the members of the bar can do much to remedy the evil. My own experience is that in at least half the causes no expert is necessary. Their advice is only needed in electrical and chemical cases and in cases involving intricate machines. Comparatively few of the causes presented to the courts are upon such patents. Any judge competent to hear a patent cause ought to be able to understand the simple improvements covered by a large majority of patents. It would also tend to shorten the record if counsel would agree not to call more than one expert on each side. I have in mind several cases where from four to five experts were called on a side, each one repeating in different language what was said by his predecessor and adding nothing whatever to the solution of the question presented. Perhaps a rule of the court limiting experts to one on each side, unless the court by a previous order permits a larger number to be called, would help in this direction.

While I am not sanguine enough to believe that the question can be settled satisfactorily for some time to come, I am confident that all intelligent discussion of the subject brings us nearer to the desired goal.

Thanking you for sending me the paper, I am

Very truly yours,

ALFRED C. COXE.

## SUPREME COURT OF THE UNITED STATES.

Washington, May 29, 1900.

J. E. Hindon Hyde, Esq.,
120 Broadway, New York.

Dear Sir :—I have to acknowledge receipt of your letter of May 19th, enclosing a copy of a paper upon expert evidence.

My own experience leads me to believe that but little weight can be given to the mere statement of an expert, unless it be fortified by substantial reasons. In the majority of cases these reasons may be stated as well by counsel who are thoroughly informed of their case as by experts. In the trial of admiralty cases, in which I have had large experience, I never permitted experts to be sworn unless I requested it, but usually called upon two to sit with me upon the bench and give me their advice. These two I selected from men whom I knew to be acquainted with the subject, and their assistance was of great value. In patent cases experts are always sworn and are sometimes very useful, although I have always treated them as retained by the party producing them to make the best case they can for him. My own conviction is that it would be better for the court to select its own experts from whom an unbiased expression of opinion could be had. I do not mean to accuse experts of being intentionally unfair, but few men can avoid a natural bias toward the party calling them. There is a difficulty in having professional experts who are known to the public generally, and who would be apt to be approached by parties interested ; but if the judge were permitted to select his own experts in each case I think their opinions might become of great value.

Very truly yours,

H. B. Brown.

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## UNITED STATES CIRCUIT COURT.

### Judge's Chambers.

New York City, July 27, 1900.

My Dear Mr. Hyde :—I have received your note suggesting comment by myself on the proposed change in the practice, whereby an expert might be selected as a technical adviser to the court to whom the judges could refer in technical matters. Of course, if this were done, and it became correct practice for the judge to rely upon him, it is quite possible that our work would be easier, and may be the decisions more uniform, since the mental processes of the single expert would be largely substituted for those of the several judges. In view, however, of the contradictions now found to exist between experts of the highest standing, I should think any great increase in accuracy would be problematical. However, if that be what the bar and the litigants would prefer, the proposed change is one to be favored, since they would be better satisfied with results—at least such is, of course, the expectation, although it is not impossible that the defeated party would find much to criticize in the expert's recommendations.

I do not understand whether it is proposed to select one expert, who will advise as to dye-stuff compounds, steam engines, sewing machines and electricity, or whether one is to be selected for each case. Speaking from my own standpoint, I am sure my own work would be much easier and in many instances—

perhaps in most instances—my opinions would be more nearly right, if in every complicated case I could turn for expert advice upon the conflicting technical evidence to some one who was to be accepted as an authority—*facile princeps*—in the art. If, however, the selection of such technical adviser rested with myself, the additional responsibility thereby entailed would add a new terror to the hearing of patent causes.

Upon the proposed suggestion, however, I stand entirely neutral; whatever will suit the bar will suit me; the personal equation is not to be considered.

I remain, faithfully yours,

E. HENRY LACOMBE.

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UNITED STATES CIRCUIT COURT.

JUDGE'S CHAMBERS.

Cazenovia, N. Y., Aug. 1, 1900.

J. E. HINDON HYDE, ESQ.,

Dear Mr. Hyde:—I have read with great interest and pleasure a copy of your admirable address on "Experts and Expert Evidence" which you have been kind enough to send to me. I am very decidedly favorable to the suggestion, made near its close, that the court should be permitted to have its own expert as a technical adviser, especially in the more complicated patent causes. The opinion of such an adviser upon the scope of claims and upon the question of infringements would be often of the greatest value. When experts are produced by the parties, the judges are not unlikely to regard their testimony merely as arguments under oath, where prepossessions and bias, or undue zeal, often generate erroneous conclusions. Indeed, much of the expert testimony which judges are called upon to read is largely or wholly disregarded. The most conscientious experts can, as lawyers generally do, convince themselves by their own arguments of the correctness of their positions. The conclusions of an expert selected by the court, or concurrently by the parties, for his qualifications in the particular case, would command genuine confidence, would largely control the decision of doubtful questions, and would relieve the court of great responsibility. I shall welcome the day when experts thus selected may supplement, if not supersede, the production of experts by the respective parties. Such an innovation would also be in the interests of economy and a speedier conduct of litigations.

Very truly yours,

WM. J. WALLACE.

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UNITED STATES DISTRICT COURT—DISTRICT OF NEW JERSEY.

JUDGE'S CHAMBERS.

Newark, N. J., Sept. 15, 1900.

My Dear Mr. Hyde:—I have often felt the need of expert aid in the consideration of patent suits, but those selected by the parties are generally able to make the subject sufficiently clear to enable the judge to form a judgment. Of course, in selecting an expert to "sit with him at the hearing," the judge would choose one in whose ability he had the greatest confidence.

I would be afraid that the judge would be apt to place so much reliance upon the conclusions of his expert that the judgment ordered would in many, if not most of the cases, be that of the expert and not of the court.

Yours very truly,

ANDREW KIRKPATRICK.

## BOOKS RECEIVED BY THE INSTITUTE.

ELECTRICITY MADE SIMPLE AND TREATED NON-TECHNICALLY, by Clark Caryl Haskins. Published by Clarence Macdonald, 79 Fifth Avenue, Chicago, 233 pp. 108 illustrations, 5¼in. x 7in.

This little work is not intended for the instruction of experts, nor as a guide for professors. The author has endeavored throughout the book to bring the matter down to the level of those whose opportunities for gaining information on the branches treated has been limited.

Four chapters are devoted to Static Electricity; three each to Chemical Batteries and Light and Power; two each to Terrestrial Magnetism and Electro-Magnetism; one each to Atmospheric Electricity; Lightning Rods; Electro-Chemistry; Applied Electro-Magnetism; Force, Work and Energy; Practical Application of Ohm's Law; also a chapter upon Methods of Developing Electricity, other than Chemical.

ELECTRIC LIGHTING, A PRACTICAL EXPOSITION OF THE ART. *The Generating Plant*, Vol. I., by Francis B. Crocker, E.M., Ph.D. D. Van Nostrand Co., New York, third edition revised, 444 pp. 152 illustrations, 6¼in. x 9¼in. Price, $3.00.

The author believes that the time has now arrived when electric lighting has reached a sufficiently perfected and established state to allow of its being treated in a fairly satisfactory and permanent manner. The apparatus and methods now employed are almost as well standardized as in other arts. The dynamo, which is the most important element, is one of the most perfect machines in existence. Arc and incandescent lamps, overhead and underground wires, transformers, and almost all the other parts of electric lighting plants have also become sufficiently stereotyped. In fact, it is remarkable that of all the important features of an electric lighting system, the steam engine is the one which is now being modified to the greatest extent, although it is, of course, much older than the others.

CONTENTS:—Introduction; History of Electric Lighting; General Units and Measures; Classification and Selection of Electric Lighting Systems; The Location and General Arrangement of Electric Lighting Plants; Buildings for Electric Lighting Plants; Possible Sources of Electrical Energy; The Steam Engine, History and General Principles; Steam Boilers for Electric Lighting, Steam Engines for Electric Lighting; General Construction; Typical Forms of Steam Engine for Electric Lighting; Steam Engines for Electric Lighting; Selection, Installation and Management; Gas, Oil and Hot-Air Engines; Water-Wheels and Windmills; Mechanical Connections between Engines and Dynamos; Direct Coupling, Belting and Shafting; Toothed, Friction and other Gearing; Principles and Construction of Dynamos; Typical forms of Dynamos for Electric Lighting; The Practical Management of Dynamos; Accumulators, Principles, Construction and Management; Applications of Accumulators in Electric Lighting; Switchboards, including Switches, Fuses and Circuit Breakers; Electrical Measuring Instruments; Lightning Arresters.

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